Wheat Production in the Eastern United States

Farmers' Bulletin No. 2006

UNITED STATES DEPARTMENT OF AGRICULTURE

ABOUT one-fourth of the wheat grown in this country is produced in the so-called eastern region, which includes all the States east of the Mississippi River and adjacent areas west of the river that have 30 inches or more average annual precipitation. Included are the eastern parts of Texas and Oklahoma, southeastern Kansas, Missouri, Arkansas, and Illinois. The western boundary is based on the type of farming and class of wheat that predominate. It is somewhat irregular and overlapping, as there is no sharp line of demarcation between the soft winter, hard winter, and spring wheat regions.

The soft red winter wheat grown in this region is used for cake, cracker, biscuit, pastry, and general-purpose flours, and the white wheat is used for prepared breakfast cereals and for weaker flours used in making cookies. Most of the wheat is softer in texture and lower in protein content than the hard wheats, used for making bread flours, that are grown in the Plains States.

In this eastern wheat-producing region, wheat is one of the leading crops. It is grown largely as a supplement to other crops. It fits well into rotations and serves as a cover crop to retard soil erosion and leaching during the late fall, winter, and early spring. A good cash crop, wheat also provides very satisfactory pasture in the fall and winter, and its use for this purpose is increasing.

About 65 different varieties of wheat are grown commercially in the east, with the soft red winter wheat predominant. White winter wheats are grown extensively in New York and Michigan, and hard red winter varieties are grown in Illinois and Missouri.

This bulletin describes the varieties suitable for different States, discusses methods and practices contributing to success, such as early preparation of the ground, fertilization, timely seeding with reference to possible damage from the hessian fly, and winterkilling. Diseases and their control are discussed.

The bulletin is a revision of and supersedes Farmers' Bulletin 1817, Growing Wheat in the Eastern United States.

Washington, D. C. Issued September 1951

WHEAT PRODUCTION IN THE EASTERN UNITED STATES

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WHEAT AND FARMING IN THE EAST

MOST OF THE WHEAT of the eastern United States is produced in a relatively narrow irregular belt extending across central Missouri and Illinois, including most of Indiana, Ohio, southern Michigan, southern Pennsylvania, Maryland, and Delaware. Less important areas include western New York, the piedmont (foot of the mountain) areas and the mountain valleys of Georgia, North Carolina, South Carolina, Virginia, and eastern Tennessee. There are scattered producing areas in Kentucky and central Tennessee. Although the wheat crop in these last-named areas has little national import, it plays an important part in the local agriculture, which depends to a considerable extent on how successfully wheat is grown (fig. 1).

The agriculture of the entire region is generally diversified. Dairying and the raising of livestock and poultry are leading industries. The production of corn, soybeans, hay, and pasture crops is important. Cotton is grown extensively in the South.

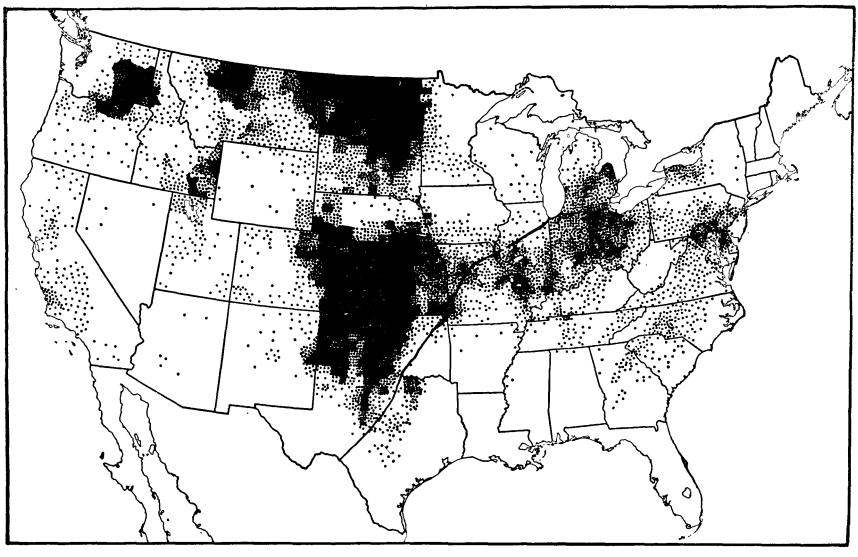

Figure 1.—Distribution of all wheat in the United States in 1949. Soft wheat is the principal kind grown east of the heavy black line.

In this region, wheat is usually grown as a supplement to and in rotation with other crops, rather than as the primary crop for grain. Wheat fits well into the different rotations and serves as a cover crop in late fall, winter, and early spring, retarding soil erosion and leaching when the land otherwise would be bare. Most rotations include a grass—timothy, for example—and a legume, as red clover, alsike, lespedeza, or sweetclover, either singly or in various combinations. These can be seeded with the wheat in the fall or in the wheat in late winter or early spring, according to the kind of grass or legume, and hence can be established without the loss of a year's time.

Wheat is often grown because it can be converted into cash. In the dairy sections it provides satisfactory pasture in the fall and early spring, and its use for this purpose is increasing. Young wheat plants are high in digestible protein, usually 18 to 20 percent, and sometimes as high as 25 percent. In the Southern States wheat occasionally is grown for grazing or hay, especially where winter oats cannot be depended upon to survive the winter. The value of the wheat straw in some areas approaches that of the grain. In addition to serving as roughage for livestock, the straw is valuable for bedding and in conserving and supplementing the manure.

Much of the soft wheat grown in this region is milled and sold to the bakery trade. There are also many small mills in the Southeast where wheat is ground into flour for home use.

Wheat grain is also a valuable feed for all classes of livestock. It is high in digestible nutrients, including protein. For most economical results it should be coarsely ground or rolled and under some conditions should be mixed with less concentrated feeds. Too finely ground wheat may form a heavy pasty mass in the

stomach and cause an animal to lose appetite. Best results are obtained when the wheat constitutes not more than one-fourth to one-half the grain ration, with the rest corn, barley, or oats. For dairy cows, the grain ration should be supplemented with a protein concentrate.

CLIMATE AND SOIL FOR WHEAT

Wheat is adapted to a wide range of climate and soil. It is grown from the Equator to the Arctic Circle, and from sea level to elevations above 10,000 feet. High rainfall, especially if accompanied by moderate or high temperature, is generally unfavorable to wheat production, because it intensifies disease and insect attacks and difficulties in harvesting and threshing unless there is a comparatively dry season at maturity.

In the eastern United States wheat is commonly grown in rotations with corn, soybeans, and clovers. Soils capable of producing satisfactory yields of these crops are well adapted for wheat. Like other small grains, wheat yields best on medium- to heavy-textured, well-drained soils with well-balanced fertility. A high nitrogen content in the soil in relation to other nutrients causes excessive vegetative growth and lodging and a predisposition to attacks by diseases. It is not a satisfactory crop on poor, sandy soils or on poorly drained soils.

KINDS OF WHEAT

Wheat was unknown in North America prior to the discovery of the New World by Columbus in 1492; hence, the varieties that are now grown were introduced from the Old World or are descendants of such varieties. Columbus brought wheat with him from Spain on his voyage to the West Indies in 1494. Whether this particular introduction found its way to what is now the United States is not known, but it is certain that Spanish varieties were later introduced. The early English colonists brought seed with them, as did colonists from Holland and Sweden. Red May, which is still grown, probably descended from Red Lammas, a variety grown in England during the seventeenth century and in Virginia prior to the Revolution.

It was traditional for colonists to take seed with them when moving to new countries. Consequently it is more than probable that varieties were introduced into the eastern United States from nearly every country of Europe during the period of colonization. In later years agricultural societies and State and Federal Governments took an active part in introducing new varieties.

Many of the varieties brought to the eastern United States during the Colonial period proved to be poorly adapted and soon disappeared. Others persisted for a time and were then replaced by better ones. A few are still grown on a small acreage. The changes that have been brought about may perhaps be best appreciated from the fact that, although no less than 65 distinct varieties are grown in the eastern United States at the present time, less than half a dozen of those in existence 100 years ago are grown today.

Since about 1915 efforts to obtain better varieties have depended mostly on hybridization, followed by selection, rather than on introduction from foreign countries. By this method the desirable traits of several varieties have been combined into one and the extreme fluctuations in yield reduced. Most of the acreage is now sown to improved varieties developed cooperatively by State experiment stations and the United States Department of Agriculture.

Nearly all wheat grown in the eastern United States is seeded in the fall and harvested the following spring or early summer. Varieties of true winter wheat, if sown in the spring, seldom produce heads, or at best only a few heads, and for all practical purposes result in failure. True winter wheat varieties have a low temperature requirement that must be satisfied before normal heading occurs. Where winter wheat will survive the winters, spring wheat is relatively unsatisfactory. Conditions for seeding are less satisfactory in the spring than in the fall. Spring wheat ripens later and hence is more likely to be injured by rust, scab, and other diseases, and by unfavorable weather. Yields usually are much less and the quality poorer than from the better varieties of winter wheat. Spring wheats are grown occasionally in the New England States and in the States bordering the Great Lakes, but the acreage is small.

Winter wheat falls into three classes: Hard red winter, soft red winter, and white. More than 90 percent of the wheat grown in the eastern United States is soft red winter. Soft white winter wheat is also grown in New York, Michigan, northern Ohio, and New Jersey. Hard red winter wheat is grown on a considerable acreage in Illinois and Missouri. The soft winter varieties have soft grain and are usually grown in humid climates on soils relatively low in available nitrogen. Under these conditions they produce grain low in protein. This grain produces flour best suited for making cakes, crackers, cookies, and similar bakery products and for general-purpose family flours. Excellent bread, however, can be made from most varieties of soft wheat when the protein content is not too low or from the flour of blends of soft and hard wheat.

In general, hard wheat is grown in areas with less than 30 inches of rainfall and on soils relatively rich in nitrogen, which favor the production of grain of high protein content. When hard wheats are grown in the eastern United States the grain is similar in protein content to soft varieties grown under the same conditions. It is harder than that of soft wheats, but much softer than when grown in the semiarid Great Plains. The mottled hard and soft condition of hard wheat kernels is known as yellow berry. Such grain is less desirable for low-protein flours than that produced by typical soft varieties. Hard winter wheat varieties are nevertheless grown in central Illinois and in northwestern Missouri because of their superior winter hardiness and productivity.

CHOOSING A VARIETY

About 65 distinct varieties of soft winter wheat are now grown on a commercial scale in the eastern United States. Some have

red, others have white, grain; some have beards, and others are beardless. They also differ greatly in color of chaff and straw, in height, and especially in such important characters as winter hardiness, yield, quality, resistance to diseases, time of heading and ripening, resistance to lodging, and ability to tiller. Because of the large number of varieties available and their great variation with respect to the above characteristics, the choice of the best variety for a particular farm often is difficult. For example: Is it better to grow a red wheat or a white wheat? Do bearded varieties usually yield better than beardless varieties? Should disease resistance be considered? Are there important differences in quality, or is it sufficient to know that a given variety can be depended upon to give satisfactory yields? These and other questions should be considered by the grower.

Yield is the characteristic by which a variety is judged most commonly. No variety may be considered satisfactory unless it is able to produce a good yield in comparison with others. However, yielding ability, or the tendency to produce a generally satisfactory yield over a period of years, is a difficult characteristic to judge. One reason for this is the great climatic variations from year to year. Thus, a new variety may produce a very good yield for 2 or 3 years, when it is first introduced, but because of susceptibility to winterkilling, disease, or other factors, it may later prove to be very unsatisfactory. For this reason farmers may well be skeptical of new, untried varieties. The only way to determine whether a given variety is a good yielder is to grow it for a number of years, preferably in comparison with other well-known standard varieties. Usually this can be done most satisfactorily by agricultural experiment stations, where information should be sought if there is doubt as to the worth of a variety.

Soft red varieties should be grown over most of the region under discussion. Soft white varieties are grown in western New York and in Michigan, where there is a special demand for this class for the manufacture of prepared breakfast cereals and for the milling of low-protein, weak-gluten flours for special uses.

Other things being equal, farmers of the Eastern States prefer beardless (or awnless) varieties. The beards are somewhat objectionable in harvesting and threshing, and they may cause sore mouths when the straw is fed to farm animals. Only about 29 percent of the wheat produced in the eastern United States is of bearded varieties. There is considerable evidence to show that the beards aid in the filling of the grain, with the result that bearded wheats tend to have more plump grain than do beardless varieties. In some areas bearded varieties are grown because they happen to be more winter-hardy or more resistant to diseases. There is, however, no consistent relation between the presence of beards and yield in the Eastern States, and other varietal characteristics are generally more important. It is best to depend upon performance records in choosing varieties.

A satisfactory winter wheat must be sufficiently hardy to survive winters of average or more than average severity in the locality where it is to be grown. Winters fluctuate greatly in this respect. In 1929, for example, approximately two-thirds of the

acreage of winter wheat in Illinois, Indiana, and Ohio was winterkilled, and in 1934 and 1935 the New York crop suffered heavily from the same cause.

Winterkilling in the Eastern States often is due to heaving as a result of the alternate freezing and thawing of the soil in late winter and early spring. In this process ice forming below the surface of the soil lifts the plants above the ground, and the roots are broken and exposed. The plants may be partly or completely killed. Death due to freezing of the plant tissue is also common. Probably in many cases winterkilling is the combined result of these two types of injury and of standing water.

In general, the soft winter varieties are more resistant to heaving and less resistant to low temperatures than are hard winter varieties. Some progress has been made in producing new varieties that possess resistance to both causes of cold injury.

If conditions are favorable throughout the growing season, late-maturing varieties produce the highest yields. Usually, however, conditions are not favorable throughout the season. Rust, scab, powdery mildew, septoria, and other diseases appear in late spring; and in some areas the high temperatures of early summer are not the most favorable for growth. On poor soils the supply of mineral elements may be insufficient to carry a late crop to maturity in the most satisfactory manner. For these reasons early-maturing or medium-maturing varieties usually produce better yields than those that require a long growth period.

It is often desirable to grow an early variety to get the crop off the land, so that harvest will not interfere with other farm work, or to give a grass or legume crop seeded with the wheat an opportunity to develop before hot weather, or to prepare the land for a summer crop. A delay of even a few days in harvesting may be very important.

Ability to resist lodging is a very important consideration in choosing a variety for this region, especially for soils rich in nitrogen, where lodging frequently occurs. The more general use of the combine for harvesting has made strong straw especially important, since the harvest is delayed one or more weeks so the grain will be dry enough to store. Lodged grain is difficult and expensive to harvest. Lodging that occurs before the grain is ripe interferes with the filling of the heads. This results in a low yield of grain with a low test weight and poor quality. Varieties differ greatly in resistance to lodging. In general, the hard winter varieties have weak straw and lodge easily. Most of the soft red and soft white varieties have reasonably stiff straw, and some are very resistant to lodging.

The most important wheat diseases in the eastern United States are leaf rust, septoria leaf and glume blotch, stem rust, powdery mildew, loose smut, bunt or stinking smut, mosaic, and scab (see p. 33). Bunt, or stinking smut, and loose smut can be prevented by seed treatment, although the hot-water treatment for loose smut cannot be given without special equipment. Most other diseases can be controlled only by the use of resistant varieties so far as they are available. It is obviously desirable to use resistant varieties if they are satisfactory in other respects. Resistance to

the various diseases will be mentioned in the discussion of each variety.

Only varieties of satisfactory quality for making the products usually made from soft wheat should be grown. At times the hard, high-protein, strong-gluten wheat of the Great Plains sells at a premium over soft winter wheat, and the question often arises whether high-protein hard wheat cannot and should not be grown in the eastern United States. Hard wheats grown in this region would have low protein content and would not be satisfactory either for bread or for cakes, cookies, and crackers.

VARIETIES FOR THE EASTERN UNITED STATES

It is impracticable to give an adequate description of all of the varieties grown in the eastern United States; consequently, the discussion that follows is limited to those grown on larger acreages and to the newer varieties. For convenience they are arranged in groups according to head type and grain color.

Varieties With Soft Red Grain, Beardless Heads, and Glabrous White or Yellow Chaff

The leading varieties of this group are Clarkan, Fairfield, Vigo, Fultz, Trumbull, Fulhio, Forward, Nured, Leap, Leapland, Vahart, Purplestraw, Flint, Redhart, Carala, Hardired, Sanford, Chancellor, Atlas 50, Atlas 66, and Seabreeze. The first 11 are true winter varieties with fair to good winter hardiness. The last 10 range from a winter-intermediate to a spring habit of growth, but all are grown from fall seeding in the South, where winters are mild.

Clarkan

Clarkan probably is the result of a cross between Blackhull, a hard red winter wheat, and Harvest Queen, an old variety of soft wheat. It was selected by Earl G. Clark, a farmer living near Sedgwick, Kans., and was distributed by him in 1934. It was grown on about 939,000 acres in 1949, of which about 760,000 were in Missouri (fig. 2). Clarkan has stiff but rather tall straw and a high test weight and yields well in Missouri and adjacent areas. The variety is very susceptible to loose smut, mosaic, leaf rust, and stem rust. Its quality is acceptable, but the grain tends to be slightly harder in texture and stronger in gluten properties than the better quality soft red wheats. It is recommended for growing in Missouri and Kentucky.

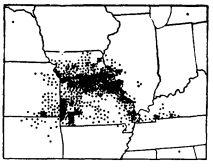

Figure 2.—Distribution of Clarkan in 1949. Estimated area, 939,098 acres.

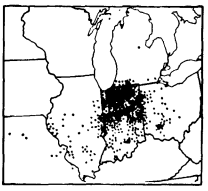

Figure 3.—Distribution of Fairfield in 1949. Estimated area, 691,488 acres.

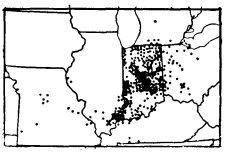

Figure 4.—Distribution of Vigo in 1949. Estimated area, 452,427 acres.

Fairfield

Fairfield was developed from a cross between Purkof and Fulhio made in 1926 at the Purdue Agricultural Experiment Station. It was distributed in Indiana in 1942. In 1949 it was grown on about 691,000 acres, of which about 518,000 acres were in Indiana (fig. 3). It is relatively winter-hardy among the soft wheats. It is resistant to mosaic, to many races of loose smut, and is somewhat resistant to leaf rust, but is susceptible to stem rust. It has yielded well in northern Indiana and has good, soft wheat quality. It is recommended for growing in northern Indiana.

Vigo

Vigo resulted from a cross made in 1932 at the Purdue Agricultural Experiment Station between Trumbull and a leaf-rust-resistant selection from Fultz. Distributed in Indiana in the fall of 1946, it was grown on about 452,000 acres in 1949, of which 365,000 were in Indiana (fig. 4). It is resistant to leaf rust and mosaic and to some races of loose smut, but is susceptible to stem rust. It is relatively winter-hardy among the soft wheats, has yielded well, and has good soft wheat quality. Vigo is recommended for growing in Indiana, southern Illinois, Missouri, Kentucky, and western Ohio.

Fultz

Fultz was grown more extensively than any other variety in the eastern United States for many years prior to 1944. It is one of the older varieties, having been originated in 1862 by Abraham Fultz, who increased it from three heads found in a field of bearded wheat in Mifflin County, Pa. It owes its wide distribution to general all-round excellence rather than to any particular characteristic. The straw is rather short, moderately stiff, and seldom lodges; the grain is of good quality, and under many conditions yields are satisfactory. It is resistant to loose smut and mosaic but is susceptible to leaf and stem rusts. It was grown on about 377,000 acres in the eastern United States in 1949 (fig. 5).

The plants are of medium height, mature in midseason, and have a purple or reddish straw when ripe. Some local strains of Fultz grown in southern Indiana and adjacent States are relatively early. The kernels are soft, rather small, and pale red in color. This variety produces soft wheat flour of excellent quality.

Fultz also is known as Bluestem, Hickman, Posey, Snow, and by other names. It is not now recommended for growing in any State.

Trumbull

Trumbull, a selection from Fultz made about 1908 at the Ohio Agricultural Experiment Station, has a slightly taller, stiffer straw and in Ohio has yielded somewhat better than Fultz. The straw is a very light purple, and the heads are more erect than those of the parent. Trumbull also is resistant to loose smut and mosaic, but is susceptible to leaf and stem rusts. It is similar to Fultz in grain quality. In recent years, it has been largely replaced in Ohio by

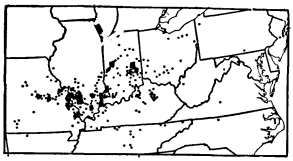

Figure 5.—Distribution of Fultz in 1949. Estimated area, 377,243 acres.

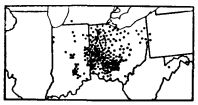

Figure 6.—Distribution of Trumbull in 1949. Estimated area, 300,954 acres.

Thorne but was still grown on about 301,000 acres in 1949 (fig. 6), of which about 244,000 acres were in Ohio. It is recommended for Ohio.

Fulhio

Fulhio also is a selection from Fultz made at the Ohio station, and in appearance, performance, and reaction to diseases it is very similar to the parent variety. It was grown on about 178,000 acres in 1949, of which about 97,000 acres were in southern Illinois and 56,000 in Ohio. It is recommended for growing in West Virginia.

Forward

Forward was originated from a beardless plant found in the bearded variety Fulcaster at the New York (Cornell) Agricultural Experiment Station. It was first distributed in 1920. In 1949 it was grown on about 140,000 acres. It is approximately as hardy as Fulcaster or Fultz and has short, stiff straw that does not lodge easily. It is resistant to several races of loose smut, but is susceptible to leaf and stem rusts. The grain is of satisfactory soft wheat quality. It is not recommended for any State.

Nured

Nured was developed from a cross between Forward and Dietz, which is the same as Fulcaster, at the New York (Cornell) Experiment Station. It was distributed in 1939 as a high-yielding red-grain variety for areas of New York in which a feed wheat is desired. It was grown on about 19,000 acres in 1949, of which about 9,000 acres were in New York and 7,000 in Pennsylvania. It is resistant to mosaic, to some races of loose smut, and is moderately resistant to mildew. It is susceptible to leaf and stem rusts. It is recommended for growing in New York where a red wheat is desired and in Pennsylvania and West Virginia.

Leap

Leap is an old variety that has good-quality grain, a reasonably strong straw, and high resistance to loose smut. It is susceptible to leaf and stem rusts. It is not winter-hardy but is satisfactory in this respect for growing at the lower elevations in Maryland and Virginia. It was grown on about 127,000 acres in 1949.

The variety usually can be distinguished from other beardless varieties by its yellow straw; by rather long, lax, tapering, and nodding heads; and by brownish stripes on the chaff, which give the head a yellowish appearance. It is recommended for growing in Virginia.

Leapland

Leapland, a selection from Leap made at the Maryland Agricultural Experiment Station, is very similar to Leap in plant characters and reaction to diseases. It has given higher yields and has largely replaced Leap in Maryland, where it is recommended. It was grown on about 49,000 acres in 1949, of which 31,000 were in Maryland.

Vahart

Vahart was selected from Redhart at the Virginia Agricultural Experiment Station at Blacksburg in 1930. It was distributed in 1945 and was grown on about 61,000 acres in 1949, almost entirely in Virginia. It is recommended for growing in that State because of its high yields and resistance to some races of loose smut and mildew. It is susceptible to leaf and stem rusts. The grain of Vahart is somewhat harder than that of the typical soft wheats but is accepted as satisfactory by the milling trade in the area where it is grown. It matures a week later than Redhart 5.

Purplestraw

Purplestraw was for a long time the leading variety in the Lower Piedmont and the Coastal Plain from Virginia to Mississippi, but its acreage has greatly decreased since the distribution of improved varieties. It was grown on about 101,000 acres in 1949. Its early maturity was a decided advantage before resistant varieties were developed in enabling it to escape damage from leaf rust in this area. It is one of the oldest varieties in the United States, its known history extending back more than 150 years. Probably because of its long history in this country, it is known by a number of names, including Alabama Bluestem, Georgia Bluestem, and Ripley.

Purplestraw tillers freely and has rather fine straw, but it is not sufficiently winter-hardy to be grown in the mountain valleys or farther north. It is not now recommended for any State.

Flint

Flint, also an old variety of unknown origin, was grown on about 65,000 acres in 1949, of which 29,000 were in Tennessee. Like Purplestraw, which it closely resembles, it has been grown from Virginia to Arkansas and south. The names Early May, Red May, and Little May are commonly used for this variety. It is not recommended for any State.

Redhart

The original Redhart was a selection from Flint made by the Coker's Pedigreed Seed Co., of Hartsville, S. C. It is no longer grown. Redhart 3 and later selections resulted from a cross between Redhart 1 and a variety named Golden Chaff. The Redhart 5 now being recommended is a week earlier than the original Redhart distributed in 1921. Redhart was grown on about 605,000 acres in 1949, extending from Delaware to Arkansas (fig. 7). It is early and has stiff white straw. It is susceptible to leaf and stem rusts. The kernels are red and soft, although harder than

many soft wheat varieties. The grain quality is accepted as good by the milling trade in the South. Redhart is recommended for growing on the Coastal Plain and Lower Piedmont of North Carolina and in South Carolina when an early variety is desired, but should not be grown where winter injury or late spring frosts are likely to occur.

Carala

Carala was selected from Alabama Bluestem, a strain of Purplestraw, at the North Carolina Experiment Station in 1929 and distributed in 1940. In 1949 it was grown on about 72,000 acres, of which 36,000 were in North Carolina. It is similar to Purplestraw except that Carala has white stems and yields higher. It is recommended for growing on the Piedmont and Coastal Plain in North Carolina.

Hardired

Hardired was developed by the Coker's Pedigreed Seed Co., of Hartsville, S. C., from a cross between a selection from Hope-Hussar and Flint made in 1932 by the Division of Cereal Crops and Diseases of the United States Department of Agriculture. It was distributed by the above-mentioned seed company in 1940 and became widely grown in the South. About 110,000 acres were grown in 1949.

Hardired, like most varieties grown in the South, is not a true winter variety and is not very winter-hardy. It has some resistance to leaf rust and has given good yields. It was resistant to mildew in the field prior to about 1945, at which time a race to which it was very susceptible became prevalent. Since then its acreage has decreased rapidly. Its grain is semihard but of satisfactory quality in the area where it is grown. It is recommended for South Carolina, Alabama, and Arkansas.

Sanford

Sanford was developed in cooperative investigations at the Georgia Agricultural Experiment Station, at Experiment. It was developed from leaf-rust-resistant selections of Kanred × Purplestraw that were backcrossed twice to Purplestraw. It was distributed to growers in 1940, and about 165,000 acres were grown in 1949, of which 148,000 were in Georgia. Sanford is very similar to Purplestraw in plant and kernel characters but has some resistance to leaf rust and has given higher yields. It has been grown extensively in Georgia and adjacent States but is rapidly being replaced by Chancellor. Sanett, a strain of Sanford, was grown on about 5,000 acres in 1949.

Chancellor

Chancellor is a leaf-rust-resistant variety that is similar to Purplestraw in plant characters and grain quality. It has yielded significantly higher than Purplestraw in the South. It has good-quality soft grain but is very susceptible to mildew. Chancellor was developed in cooperative investigations at the Georgia Agricultural Experiment Station at Experiment by crossing a selection

from (Carina × Mediterranean) × (Dietz × Carina) with a selection from Purplestraw × Kanred and backcrossing twice to Purplestraw. It was distributed to growers in the fall of 1947 and was grown on about 10,000 acres in 1949. It is recommended for Georgia, Alabama, Mississippi, and Arkansas.

Atlas 50

Atlas 50 was developed in cooperative investigations at the North Carolina Experiment Station from a cross between Frondoso, a leaf- and stem-rust-resistant wheat from Brazil, and a selection from a cross between Redhart 3 and Noll 28. Noll 28 was from a cross between Hussar and Forward made at State College, Pa. Atlas 50 is resistant to most races of leaf rust and somewhat resistant to mildew. It has given high yields in the Purplestraw area of the South. It is about a week later than Purplestraw and has stiff straw and soft to semihard grain of good quality. It is not a true winter variety and is not adapted for growing outside the Purplestraw area. Atlas 50 was distributed in the fall of 1948 and is recommended for growing in the Piedmont and Coastal Plain of North Carolina.

Atlas 66

Atlas 66 has the same parentage and history as Atlas 50 and is very similar to it in plant characters. It is more resistant to leaf and stem rusts but is susceptible to mildew. It also is recommended for the Piedmont and Coastal Plain of North Carolina.

Seabreeze

Seabreeze was developed for growing as a feed grain and for grazing in southern Texas. It makes a vigorous, leafy growth during the short days of winter and is resistant to many races of stem and leaf rust. It has some resistance to loose smut and to mildew. It is very early and is susceptible to frosts when grown farther north.

Seabreeze was developed in cooperative investigations at the Texas Agricultural Experiment Station from a cross made in 1938 between Gasta and a selection from a Mediterranean and Hope cross. Seabreeze was distributed in the fall of 1945. About 7,000 acres were grown in 1949, all in southern Texas.

Varieties With Soft Red Grain, Beardless Heads, and Glabrous Brown or Red Chaff

This group differs from the previous group in having brown or red instead of white or yellow chaff. The heads are smooth and beardless and the kernels red. The leading varieties are Thorne, Red May, Currell, Poole, and Moking. All are true winter wheats.

Thorne

Thorne was developed at the Ohio Agricultural Experiment Station from a cross between Portage and Fulcaster. It was distributed in 1937 and soon became grown on more acres than any other variety of soft wheat. It was grown on about 3,448,000 acres in 1949 (fig. 8). It is resistant to many races of loose smut and to mosaic but is susceptible to both leaf and stem rust and scab. It is a high-yielding variety, but low in test weight, with

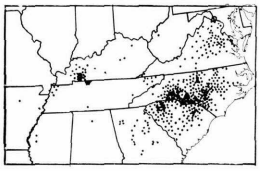

Figure 7—Distribution of Redhart in 1949. Estimated area, 604,624 acres.

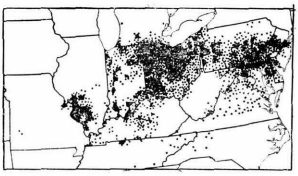

Figure 8.—Distribution of Thorne in 1949. Estimated area, 3,447,661 acres.

very stiff straw, and the grain has good soft wheat quality. It is not so winter-hardy as some other soft wheat varieties in States west of Ohio. Heads of Thorne are shown in figure 9. Thorne is recommended for Ohio, Pennsylvania, New Jersey, Delaware, Virginia, West Virginia, Indiana, Kentucky, and Tennessee.

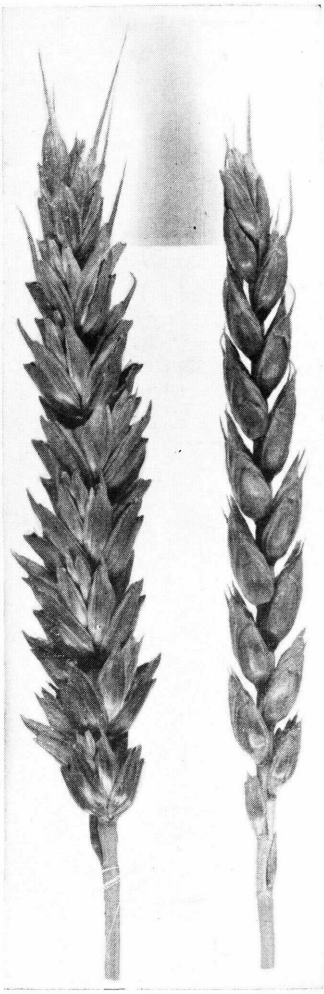

Figure 9.—Heads of Thorne.

Seneca

Seneca, a selection from the same cross as Thorne, is very similar to that variety, except that it has a higher test weight, a slightly stiffer straw, and a slightly higher yield. It was distributed in Ohio in the fall of 1949 and is recommended in place of Thorne.

Red May

Red May is grown in Indiana and Illinois as Michigan Amber and in Missouri as Michigan Wonder. The variety has been grown extensively since 1845 as Red May, whereas the names Michigan Amber and Michigan Wonder are of more recent origin. Its history has been traced back to the Red Lammas or Yellow Lammas grown in Europe during the seventeenth century. It has been grown rather extensively throughout most of the soft red winter wheat area, but its acreage has been greatly reduced in recent years. It was grown on about 140,000 acres in 1949. It is earlier and more winter-hardy than Poole, which it resembles in other respects. Red May is not recommended for growing in any State.

Currell

Currell is earlier than the other varieties of this group. It has rather short straw, which combined with its stiffness renders it resistant to lodging. It is not very winter-hardy. Currell has excellent quality for making pastry and cake flours. The variety was grown on about 88,000 acres in 1949. It is also known as Dunbar, Gill, Kentucky 47, Pearl Prolific, and Red Prolific. The Currell strain Kentucky 47 is recommended for that State.

Poole

Poole was an important variety of wheat in Indiana and Ohio for many years but has been largely replaced by improved varieties. It was grown on about 44,000 acres in 1949, of which 19,000 were in Ohio. It is about average in winter hardiness, stiffness of straw, and time of maturity. The beardless heads with brown, smooth chaff are wide, flattened, and very nodding. Poole is not recommended for any State.

Moking

Moking (Clark's R169) was developed by the farmer-wheat-breeder, Earl G. Clark, of Sedgwick, Kans., and distributed in 1946. Its parentage is unknown, but it closely resembles Clarkan except that it has brown chaff and slightly weaker stems. It was grown on about 2,000 acres in Oklahoma in 1949. It is not a recommended variety.

Varieties With Soft Red Grain, Bearded Heads, and Glabrous White or Yellow Chaff

The varieties of this group resemble those of the first group, except that they are bearded. The following varieties of commercial importance are discussed: Fulcaster, Nittany, V. P. I. 131, Newcaster, Rudy, Nigger, Royal, Saline, Butler, Blackhawk, Nudel, and Kawvale. All are true winter wheats, and most of them are among the more winter-hardy soft wheat varieties.

Fulcaster

Fulcaster was second only to Fultz of all varieties of soft wheat in acreage in the eastern United States prior to about 1940. During recent years its acreage has decreased greatly. In 1949, though still grown in many States, the total acreage was about 354,000 acres (fig. 10).

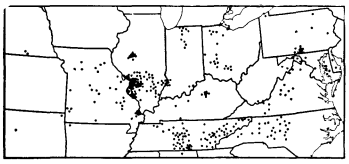

Figure 10.—Distribution of Fulcaster in 1949. Estimated area, 354,137 acres.

Fulcaster is reported to have originated in 1886 from a cross between Fultz and Lancaster (Mediterranean) by S. M. Schindel, of Hagerstown, Md. Fulcaster has been grown under many names. A few of the more important names at the present time are Dietz, Lancaster, Red Wonder, Stoner, Winter King, Marvelous, and Miracle. Fulcaster is relatively winter-hardy as compared with most soft wheats, is of medium maturity, is resistant to mosaic, and has moderate resistance to mildew. It is susceptible to leaf and stem rusts. The quality is satisfactory as a soft wheat. Under favorable dry conditions in Kansas, Texas, and Oklahoma where grain of higher protein content is produced, it is nearly equal in bread-making quality to hard red winter wheat varieties. Heads of Fulcaster are shown in figure 11. Fulcaster is recommended for the mountainous areas of North Carolina and in Tennessee.

Nittany

Nittany is a selection from Fulcaster made at the Pennsylvania Agricultural Experiment Station and was first distributed to farmers in 1918 as Pennsylvania 44. It is taller, ripens later, and under favorable conditions will produce somewhat larger yields than the parent. However, it is somewhat more inclined to lodge on rich land than is the parent variety, and it is less winter-hardy. It was grown on about 110,000 acres in 1949, of which 49,000 were in Maryland and 34,000 in Pennsylvania. It is recommended for Pennsylvania, Delaware, Virginia, and the mountain valleys of North Carolina.

V. P. I. 131

V. P. I. 131, also a selection from Fulcaster, was made by the Virginia Agricultural Experiment Station. It closely resembles Fulcaster in appearance and growth. It was grown on about 81,000 acres in 1949, of which 74,000 were in Virginia. It is recommended for growing in the mountain valleys of Virginia.

Newcaster

Newcaster is also a selection from Fulcaster that closely resembles the parent variety, except that it has white stems and is

Figure 11.—Heads of Fulcaster.

more uniform. It was developed by the Illinois Agricultural Experiment Station and was distributed in 1946. It was grown on about 43,000 acres in Illinois in 1949 and is recommended instead of Fulcaster for that State.

Rudy

Rudy was originated at Troy, Ohio, in 1871 and was a leading variety in the Ohio River Valley for many years. It was grown on about 164,000 acres in 1949, mostly in Indiana. The variety usually can be distinguished from others of this group by the yellow-white chaff with black-striped margins. It is resistant to mosaic but is susceptible to leaf and stem rust and loose smut. It has given good yields among the older varieties in this area. The kernels are large, and the quality of grain for soft wheat uses has been considered excellent. It is recommended for and grown chiefly in southern Indiana and adjacent areas.

Nigger

Nigger is somewhat similar to Rudy in plant and grain characters and in reaction to diseases. It was grown in experiments at the Ohio Agricultural Experiment Station as early as 1884, and it, like Rudy, has given good yields compared with older varieties. It was grown on about 116,000 acres in 1949, of which 85,000 were in Ohio. It is not recommended for any State.

Royal

Royal is a bearded variety with white chaff and purple stems. It is moderately resistant to stem rust, to mosaic, and to flag smut, but is susceptible to leaf rust and loose smut. It has grain of satisfactory quality, although it is stronger than many soft wheats. It originated from healthy plants selected from a field of the variety Illinois No. 2 that was infested with mosaic. It was distributed by the Illinois Agricultural Experiment Station in 1947 and was grown on about 85,000 acres in 1949, of which 84,000 were in Illinois. It is recommended for growing in Illinois and Missouri.

Saline

Saline is a new variety developed at the Illinois Agricultural Experiment Station from a cross between Wabash and Illinois No. 2. It is resistant to mosaic and moderately resistant to both stem and leaf rust, but is susceptible to loose smut. The grain of Saline is softer than that of Royal and is satisfactory for making soft wheat flours. It is recommended for growing in Illinois.

Butler

Butler, a bearded, white-chaff variety with strong straw, has given high yields in Ohio, especially in the southern part of the State where scab often causes heavy losses in Thorne. It is resistant to mosaic and flag smut and to some races of loose smut, but is very susceptible to leaf and stem rust. It has grain of excellent soft wheat quality. It was developed at the Ohio station from a cross between OSU 101–3 and Trumbull and was distributed in 1947. In 1949 it was grown on about 52,000 acres, most of which were in Ohio. It is recommended for growing in Ohio and Indiana.

Blackhawk

Blackhawk is a very winter-hardy, soft-bearded wheat with resistance to leaf rust, stinking smut, and flag smut, and moderate

resistance to loose smut and stem rust. Because of its susceptibility to mosaic, it should not be grown on mosaic-infested land. It was developed in cooperative investigations at the Wisconsin Agricultural Experiment Station from a cross between Minturki and a sister selection of Minturki. It was distributed in 1944 and was grown on about 72,000 acres in 1949. It has good soft wheat quality and is recommended for growing in Wisconsin and northern Illinois.

Nudel

Nudel was selected by the Delaware Agricultural Experiment Station from a field of wheat, probably of the Fulcaster variety. It has given good yields at that station compared with other varieties. It is similar to Fulcaster in appearance and reaction to diseases. It was distributed in Delaware in 1948 and was grown on about 700 acres in that State in 1949.

Kawvale

Kawvale was developed at the Kansas Agricultural Experiment Station as a selection from an old variety known as Indiana Swamp. It was released for distribution to Kansas farmers in 1932 and was grown on about 301,000 acres in 1949 (fig. 12). The variety is resistant to winter injury and is moderately resistant to the strains or varieties of hessian fly present in the Great Plains. It also is highly resistant to loose smut and has some resistance to leaf rust. It matures relatively early and gives high yields. The grain shatters from the heads easily and cannot be allowed to stand in the field after it is ripe. Because of poor quality for soft wheat flours, it is not recommended. While the grain of Kawvale has the external appearance of soft wheat and the variety is classed as soft red winter, the grain is hard in texture and not satisfactory for soft wheat flours. Its quality for bread-making purposes approaches that of the hard red winter wheats.

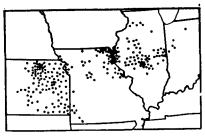

Figure 12. — Distribution of Kawvale in 1949. Estimated area, 300,594 acres.

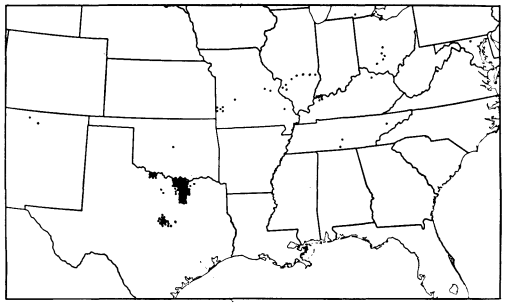

Figure 13.—Distribution of Mediterranean in 1949. Estimated area, 252,145 acres.

Varieties With Soft Red Grain, Bearded Heads, and Glabrous Brown or Red Chaff

Only five varieties of commercial importance, Mediterranean, Goens, Prairie, Austin, and Supremo, are included in this group.

The first three are true winter wheats. Austin has an intermediate and Supremo a spring habit of growth, but both are satisfactory for fall seeding in southern Texas, where winters are mild.

Mediterranean

Mediterranean is grown chiefly in north-central Texas but is widely, though sparingly, grown throughout the eastern United States (fig. 13). About 205,000 of the 252,000 acres grown in 1949 were in Texas. It has declined rapidly in importance in recent years. The most authentic history of the Mediterranean variety indicates that it was introduced from Genoa, Italy, in 1819, by John Gordon, of Wilmington, Del. During the next 30 to 50 years it spread westward to Missouri, Kansas, Oklahoma, and Texas. Mediterranean is also known by many other names, including Lancaster, Red Sea, and Swamp.

The plants are tall, mature in midseason, have purple straw, and are somewhat resistant to leaf rust. This variety is not so winter-hardy as many soft winter wheats, and it is subject to lodging. While satisfactory for making soft wheat flours, the strength of the gluten is good and by proper handling of the dough bread is approximately equal to that made from hard red winter varieties. It is not now recommended for any State.

Goens

Goens is a relatively early, bearded variety of soft red winter wheat with brown glumes that shatter rather easily when ripe. It is resistant to mosaic, but is susceptible to loose smut and to leaf and stem rusts. It has excellent quality of soft grain, a fairly strong straw, and has yielded well among the older varieties in southern Indiana, Ohio, and Illinois. Goens is an old variety, having been grown in Ohio in the early 1800's. It is also known as Baldwin, Early Red, Hall, Owen, and Shelby. It was grown on about 110,000 acres in 1949, of which 50,000 were in southern Ohio, 42,000 in southern Indiana, and 17,000 in southern Illinois. It is recommended for growing in southern Indiana.

Prairie

Prairie is a winter-hardy, bearded variety with brown chaff and stiff straw. It is resistant to mosaic, moderately resistant to stem rust, and has satisfactory soft wheat quality. It is susceptible to leaf rust and very susceptible to loose smut. Prairie was developed from healthy plants in a mosaic-infested field of Illinois No. 2 by the Illinois Agricultural Experiment Station and was distributed in 1943. It was grown on about 45,000 acres in 1949, of which 43,000 were in Illinois. It is recommended for that State.

Austin

Austin is not a true winter wheat. It has an intermediate habit of growth and is susceptible to winterkilling except where the winters are mild. It has resistance to stem rust, to some races of leaf rust, and to loose smut. Because of its susceptibility to winter injury, it should not be grown north of the Dallas and Fort Worth area in Texas. It was developed in cooperative investigations with

the Texas Agricultural Experiment Station from a cross between Mediterranean and Hope and was distributed in 1942. It was estimated that three-fourths of a million acres were grown in Texas in 1946, but because of the appearance of races of leaf rust to which it is susceptible and winter injury in some areas, the acreage was reduced to about 218,000 acres in 1949, of which 209,000 were in Texas.

Supremo

Supremo is a new leaf- and stem-rust-resistant variety that should be well adapted to southern Texas, where winters are mild. It is resistant to all described races of loose smut. It has an upright, spring habit of growth, which, along with its disease resistance, should make it very useful for winter grazing. It is susceptible to shattering in dry areas.

It was developed from a cross between Supresa and a selection from the Hope-Mediterranean cross. The cross and early selections were made cooperatively with the Texas Agricultural Experiment Station. The final selection and testing were done by The Rockefeller Foundation in cooperation with the Mexican Ministry of Agriculture in Mexico, where it was distributed for growing in 1948. Fifty bushels were returned to Texas for seeding in the fall of 1949. It is recommended for growing in southern Texas, where the winters are mild.

Varieties With Soft White Grain

Varieties with soft white grain are of importance only in New York and Michigan, where they occupy 97 and 87 percent, respectively, of the acreages sown to wheat. A small acreage is grown in Pennsylvania, Ohio, and New Jersey. Only three varieties of this class are important commercially in the Eastern States. All are beardless, and all have a true winter habit of growth. These varieties produce grain that is very soft and that mills into flour of weaker gluten strength than most of the soft red varieties. Much of the grain is used for prepared whole-grain breakfast cereals, and much of the flour milled from it is used for cookies or other products that require low gluten strength.

Yorkwin

Yorkwin is the leading variety of soft white winter wheat grown in the East. It was grown on about 1,108,000 acres in 1949, of which 885,000 were in Michigan, 204,000 in New York, and 10,000 in Pennsylvania (fig. 14). It is a high-yielding variety with beard-

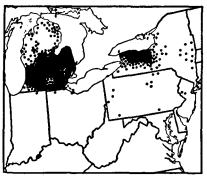

Figure 14.—Distribution of Yorkwin wheat in 1949. Estimated area, 1,107,530 acres.

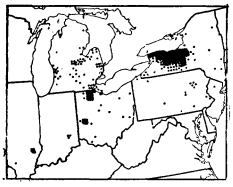

Figure 15.—Distribution of Cornell 595 in 1949. Estimated area, 335,894 acres.

less heads, white chaff, and a stiff straw that is resistant to lodging. It is resistant to several races of loose smut but is susceptible to leaf and stem rusts. It has grain of satisfactory quality, although its gluten strength is somewhat stronger than other white wheat varieties.

Yorkwin was developed in cooperation with the Cornell University Agricultural Experiment Station from a cross between Fulcaster and Goldcoin made in 1919. It was distributed to growers in 1935. It is recommended for growing in New York and Michigan.

Cornell 595

Cornell 595 has very stiff straw and is also a high-yielding variety in New York and Michigan. It has beardless heads, brown chaff, and grain of good, soft, white quality. It is resistant to mosaic and to some races of loose smut, mildew, and septoria, but is susceptible to leaf and stem rusts.

Cornell 595 was also developed in cooperation with the Cornell University Agricultural Experiment Station from crossing an F_1 hybrid between Honor and Forward with Nured and then backcrossing this latter F_1 hybrid to Honor. It was distributed in 1942 and was grown on about 336,000 acres in 1949, of which 195,000 were in New York, 66,000 in Michigan, and 49,000 in Ohio (fig. 15). It is recommended for New York, Michigan, and New Jersey.

Dawson

Dawson formerly was an important variety in Michigan, where it is still grown on about 44,000 acres, mostly under the name of American Banner. It was grown on a total of about 58,000 acres in 1949, mostly in Michigan, Ohio, and New York. Dawson was developed from a plant found in a field of Clawson wheat in 1881 by Robert Dawson, of Paris, Ontario, Canada. It has some resistance to hessian fly and has strong straw, but does not usually equal Yorkwin or Cornell 595 in yield. It has been replaced by them.

Hard Red Winter Wheat

The acreage of varieties with hard red grain has increased greatly in recent years in northern and western Missouri and now occupies nearly one-half of the wheat acreage in that State. Most of this increase in acreage consists of the relatively new variety Pawnee, which is winter-hardy, moderately resistant to hessian fly, and well adapted to the transition area between the soft red winter and the hard red winter regions. Hard red winter varieties continue to be grown on a large acreage in central Illinois and occupy about 41 percent of the wheat acreage of the State. The protein content of hard wheat varieties is approximately the same as that of soft varieties grown under the same conditions. The protein content of hard red winter varieties grown in Missouri and Illinois is lower than is desired for most hard wheat flours, and the texture of the grain makes these varieties undesirable for purposes for which soft wheat flours are used. They are used for blending with high-protein grain, and for general-purpose flours.

Pawnee is the only hard red winter variety of any importance in the Eastern States. It is winter-hardy, yields well in northern Missouri and central Illinois, and is highly resistant to loose smut. It is susceptible, however, to mosaic and should not be planted on infested land.

Pawnee was developed in cooperation with the Kansas and Nebraska stations and released in 1942. It was grown on about 944,000 acres in Missouri and 660,000 acres in Illinois in 1949. It is recommended for central Illinois.

Purkof, an awnless winter-hardy variety with hard red grain, has been grown on a considerable acreage in Indiana and Illinois in previous years, but it was grown on about 63,000 acres in 1949. Of this, about 37,000 were in Illinois and 18,000 in Indiana. Purkof was developed by the Purdue University Agricultural Experiment Station from a cross between Red May and Malakof.

Brill, a bearded winter-hardy variety with red chaff, was grown on about 43,000 acres in Illinois in 1949. It is resistant to many races of loose smut and somewhat resistant to flag smut, leaf rust, and scab, but is susceptible to mosaic and should not be grown on land infested with this disease. Brill was developed at the Illinois Agricultural Experiment Station.

The old variety Turkey, which was formerly the leading variety of hard red winter wheat in Illinois, was grown on only about 82,000 acres in that State in 1949.

Spring Wheat

Spring wheat is not grown extensively in the Eastern States, but it is grown to some extent in Wisconsin and occasionally in northern Illinois and northern New York. Henry, a bearded variety resistant to leaf and stem rust and bunt, is well adapted for growing in Wisconsin and northern Illinois, and is as well adapted as any spring variety for growing in the Northeastern States. It was developed cooperatively at the Wisconsin Agricultural Experiment Station and was grown on about 83,000 acres in that State in 1949.

GROWING WINTER WHEAT

Many factors are involved in growing a crop of wheat successfully. Only the more important factors are considered here.

ROTATIONS

It is not advisable or profitable to grow wheat continuously on the same land in the eastern United States, but wheat fits into many of the crop rotations used in this region. The crops to be used in a rotation, their sequence, management, and use are determined by the climate, length of growing season, soil type and fertility, and type of farming. The plowing under of green-manure crops is not practicable in growing wheat in the North, but is very beneficial in the South where the growing seasons are long and the winters mild. Crops like winter wheat, oats, and barley serve as good winter cover crops to reduce leaching and erosion during the winter. At the same time they may be of considerable value for pasture, especially in the South where they provide

grazing during midwinter when it is not available from other crops.

A good wheat rotation contains at least one legume and one or more cultivated or row crops, and it protects the soil from excessive leaching and erosion. In the Corn Belt these requirements are easily met with corn, soybeans, and clover. Seeding with wheat serves as a convenient and inexpensive means of obtaining a stand of clover, as the preparation of the ground for wheat suffices also for clover, even when the latter is sown in late winter. As a companion crop, wheat shades the ground less and is harvested earlier than oats and usually is more profitable than rye. Inasmuch as cattle are raised on most farms, the growing of wheat is an advantage, as wheat furnishes valuable pasture, feed, and bedding.

The fact that wheat is well suited as a companion crop for clover or grasses, whether alone or in combination, means that it should occupy a place in the rotation preceding them. Where corn can be grown successfully, it makes better use than most crops of the improved productivity of the land brought about by growing clover and grass. Corn, therefore, is usually grown following these crops.

Spring oats can be sown conveniently after corn and the crop is harvested early enough to provide plenty of time to prepare the land for wheat. Thus a natural and efficient rotation for much of the eastern United States is wheat 1 year, clover and timothy 1 or 2 years, corn 1 year, and oats 1 year. Ordinarily, the clover and timothy, or as much of the clover as is left after the first winter, is grown 2 years. On very rich soil corn may be grown 2 years successively, thus increasing the length of the rotation and the acreage of the corn crop. Corn is likely to produce the greatest amount of feed or acre return in the rotation.

Soybeans or cowpeas may be substituted very profitably for oats or for corn in many localities when an increased acreage of these crops is desired. In tobacco-growing localities, tobacco may be grown in place of the oats. Barley may occasionally be substituted for oats, but spring barley is not a very satisfactory crop on poor soil or in rotation with corn in localities where scab or chinch bugs are likely to be prevalent, as in Illinois, Iowa, and Missouri.

In recent years wheat often has been more profitable after soybeans than after corn, because soybeans are harvested earlier and the seedbed for wheat can be prepared earlier and with less effort. Hence, when these crops are grown, the rotation may well be corn, soybeans, wheat, and clover, each 1 year. Such a rotation is especially satisfactory if the soybeans are to be cut for hay. Usually all that is necessary to prepare soybean land for wheat is a thorough disking, and even this may sometimes be dispensed with if the ground is loose and mellow.

Where wheat follows corn immediately, the corn may be cut and shocked or put into the silo, thus permitting preparation of the land and seeding. When the crop is harvested with a mechanical picker or husked by hand, the stalks should be plowed under in preparing the seedbed. Wheat occasionally is seeded between the standing rows of corn with a narrow one-horse drill. In many

sections in the East it is sown between the rows of corn shocks, but this practice appears to be declining.

Some good rotations or cropping systems for the central and northern parts of the region are as follows:

Rotation No. 1: Corn; wheat; clover.
Rotation No. 2: Corn; wheat (clover and grass seeded with wheat); clover and grass 2 years.
Rotation No. 3: Corn; soybeans; wheat; red clover or sweetclover.
Rotation No. 4: Corn; oats; soybeans; wheat; clover.
Rotation No. 5: Corn; oats; wheat; clover and timothy 1 or 2 years.

Rotations No. 1, No. 2, and No. 5 are desirable where the land is subject to washing. If rotation No. 3 is used, a cover crop such as rye or rye and vetch should be seeded in or after the corn.

Lespedeza is a popular crop in areas where it can be grown, especially where an important objective is to improve the soil or prevent damage from erosion. The lespedeza seed is sown (usually broadcast) early in the spring on the fall-sown wheat, and after harvest may be pastured or permitted to make a crop of hay or seed. If wheat is to be seeded again, the land is prepared by disking after the lespedeza seed is ripe or nearly ripe. As the lespedeza reseeds itself, the wheat-lespedeza rotation may be grown continuously or lespedeza may be left for 2 years. To be fully successful an early variety of wheat should be used in the rotation. In areas where winter barley is adapted it may be substituted for wheat.

Some of the more common rotations including wheat and lespedeza are:

Rotation No. 1: Wheat; lespedeza for pasture, hay, or seed.
Rotation No. 2: Corn; wheat; lespedeza for pasture, hay, or seed; wheat.
Rotation No. 3: Corn, rye or rye and vetch as cover crops; soybeans; wheat; lespedeza for pasture, hay, or seed.

In the South, somewhat different rotations are needed because of the longer growing season, the different type of soil, the mild rainy winters that favor erosion, and the fact that cotton is an important crop. Because of the late maturity of cotton, wheat does not follow it satisfactorily in many areas. Usually, therefore, if cotton is included in the rotation, it is followed by corn or soybeans. If possible a winter cover crop such as vetch or rye and vetch should be planted between the cotton rows. On the coastal plain of Georgia and Florida lupine may be used as a winter cover crop for green manure. Winter oats may replace winter wheat in the rotation in the South. The following rotations including wheat have been found satisfactory:

Rotation No. 1: Wheat, followed by cowpeas or soybeans for hay or seed; cotton, well-fertilized, with vetch or Austrian Winter peas planted between the rows for green manure; corn.
Rotation No. 2: Wheat, followed by cowpeas or soybeans for hay or seed; corn and velvetbeans; soybeans for hay or seed.
Rotation No. 3: Wheat (clover and grass seeded with wheat in the spring); clover and grass 2 years for hay or pasture; corn, crimson clover at last cultivation; soybeans or cowpeas.

FERTILIZERS, LIME, AND MANURE

Commercial fertilizers and manure may be used to good advantage in growing the wheat crop in most areas in the Eastern

States. The best fertilizer or fertilizer combination to use on wheat or in a rotation containing it depends largely on the soil type and state of productivity of the soil. Productivity is related to the nature of the soil, its previous treatment, and climatic conditions. Usually the State agricultural experiment stations conduct fertilizer experiments on the different soil types and are prepared to make specific recommendations. Commercial fertilizer applied to the wheat crop usually pays on most of the soils of the eastern United States.

Soils of the eastern United States, except the dark-colored soils of the prairies and of low-lying, imperfectly drained areas, commonly are low in nitrogen. When the wheat plants have light-green foliage it is usually an indication of a shortage of available nitrogen. The nitrogen deficiency of future crops usually can be corrected most economically by plowing under crops of legumes, such as red clover, sweetclover, cowpeas, soybeans, or lupines. However, it is often desirable to supplement this supply with commercial nitrogen. Nitrate of soda or sulfate of ammonia was formerly used, but ammonium nitrate has recently been extensively used. A common practice is to apply nitrogen fertilizers broadcast on the surface of the ground early in the spring at the rate of about 20 pounds of nitrogen per acre.

Chemical nitrogen in the form of a complete fertilizer is often applied by an attachment to the grain drill at seeding time. The grade of fertilizer used frequently is about 4–12–4 (4 percent nitrogen, 12 percent phosphate, and 4 percent potash) and the rate of application about 300 pounds per acre. The formula and rate will vary with locality, soil type, and cropping history.

Phosphoric acid is used very generally in the growing of wheat in the eastern United States. The crop on most soils in this region responds well to application of some readily available form such as superphosphate. Occasionally a phosphorus fertilizer is used alone, but it is supplied more commonly as a mixed fertilizer such as the one mentioned above. Residual effects of phosphorus supplied to previous crops may be considerable. Raw rock phosphate is used as the sole source of phosphoric acid in parts of the Corn Belt. It is, however, usually added for the immediate benefit of the sod-forming crops of the rotation. The wheat in turn benefits from the organic forms of phosphorus produced.

As the potash content of soils of the eastern United States differs greatly, the quantity of this constituent to be used should be determined by State experiment stations or local demonstrations or tests. On many soils the potash requirements are higher than would be met by the 12 pounds in the 300-pound application of 4–12–4 fertilizer. Muriate of potash is almost the sole source of this constituent in fertilizers used for wheat.

When the soil is more than moderately acid, an application of 1 to 2 tons per acre of ground limestone sometimes is beneficial, but most of the benefit may be indirect by improving the legume crop. Wheat itself is not injured by a slightly acid soil, but most legumes grown in the rotation will be decidedly benefited by the proper use of lime.

Manure is a valuable fertilizer and soil conditioner for wheat, but it is usually used most economically when applied to the corn

crop in the rotation. On both light sandy soils and heavy clay soils, well-rotted manure plowed under supplies the humus necessary to improve the physical condition of the soil and also adds valuable nutrients, particularly nitrogen and potash. The manure may be applied before seeding or as a top dressing to the wheat in late fall or early winter.

PREPARING THE LAND

The time and method of preparing the land for wheat depends principally on the crop that precedes it. Unless rainfall is high and the land subject to erosion, it is desirable to have the land prepared considerably in advance of seeding to permit settling and the accumulation of moisture and available plant food, especially nitrates. When the land is to be plowed, as after a small-grain crop, at least a month should intervene between plowing and seeding. The soil can be plowed most easily and much better when it is in proper friable condition. This often occurs soon after harvest. After the ground dries, it is likely to turn up cloddy and lumpy and will be difficult to work into a good seedbed. If for any reason plowing must be delayed, disking the ground immediately after harvest is beneficial.

The depth of plowing should be governed to a considerable extent by the quantity of stubble, weeds, and cover crop to be turned under, and should be sufficient to do this thoroughly. Also, the plow may be run somewhat deeper if plowing is done early rather than late. A common practice is to plow 6 to 7 inches deep in July and early August, gradually decreasing the depth to 4 to 5 inches in late August and September. Ordinarily there is no advantage in plowing deeper than is here indicated. Figure 16 shows

Figure 16.—Plowing in preparation for wheat seeding.

land being plowed as the first step in preparing a seedbed for wheat.

After plowing, the ground should be disked and cultipacked, as these operations are necessary to control weeds and volunteer grain and to get the soil in condition for seeding. The use of a disk and a spike-tooth harrow for the last operation of preparing a seedbed for wheat is shown in figure 17.

Much of the acreage of wheat in the eastern United States follows corn or soybeans in rotation. Usually, in such cases the time of harvesting and the condition of the land after the crop is removed determine the preparation of the ground for wheat.

In the Corn Belt, where most of the corn is harvested with mechanical pickers, the land preferably should be plowed to turn under the cornstalks. This usually is done when spring-sown oats follow the corn, as plowing under the stalks is necessary to control the corn borer and the scab organism that lives on the stalks. When wheat is to follow corn that has been harvested with a picker there usually is not sufficient time to permit plowing before seeding wheat. The cornstalks should be thoroughly disked to permit seeding with a grain drill. The use of earlier maturing corn hybrids is increasing, and this allows more time for seedbed preparation. Corn in the Atlantic States is often cut and shocked in the field, to be husked later, but this practice appears to be diminishing. Under such conditions preparing the ground with a disk or a spring-tooth harrow is a common practice. Soybeans often leave the ground free from weeds, friable, and in good condition for seeding, with little or no preparation other than disking and harrowing.

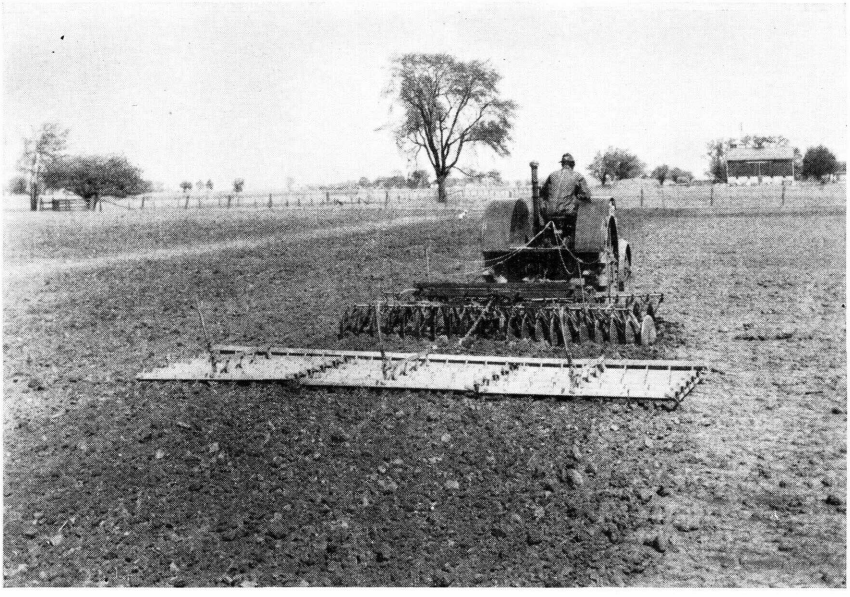

Figure 17.—Preparing a seedbed for wheat with a disk and a spike-tooth harrow.

Wheat, unlike corn, is normally self-pollinated, and for this reason an adapted variety will change very slowly, if at all, because of the locality in which it is grown. However, in such old varieties as Fultz and Fulcaster there are strains differing from each other, especially in productivity. Accordingly, it is usually preferable to obtain locally seed of the variety one wishes to grow. Once a suitable variety has been obtained, maintaining good seed requires roguing (removing mixtures) in that part of the field to be harvested for seed. It usually is best to thresh that part of the crop to be used for seed after threshing the main crop, to lessen the chance of mixing.

Weed seeds, smut balls, and broken and small kernels should be removed with the fanning mill. If wheat has a heavy infestation of bunt (stinking smut) or nematode, is moldy, or shows signs of having sprouted, it should not be used for seed.

Sound wheat that has been stored in a dry bin ordinarily germinates satisfactorily. However, if it has been wet or there is any other reason to suspect that its vitality has been injured, it should not be sown, unless it germinates at least 90 percent. The germination can be determined by a simple test. Wheat 1, 2, or even 3 years old may be used for seed if it germinates satisfactorily. Seed older than this is likely to be weak in germination.

In the early history of this country wheat was sown broadcast for want of satisfactory machinery, but at present wheat is generally sown with a drill (fig. 18). Drilling saves seed, insures better germination and more uniform stands, reduces winter injury, and almost always produces better yields. Drills are of three general types: Hoe, shoe, and single- and double-disk drills. Single-disk drills are used most commonly. Hoe drills are satisfactory only on clean land and have some advantages on stony land. Drills with rows 6 to 8 inches apart are generally the most satisfactory. If the land is subject to washing, the drilling should be crosswise of the slope or on the contour to reduce leaching or erosion.

Winter wheat in the eastern United States is usually sown at the rate of from 5 to 8 pecks per acre. Usually 6 pecks or more per acre will produce larger yields than a lesser quantity. The Ohio Agricultural Experiment Station conducted extensive tests and found that, on an average, 8 pecks per acre gave the most profitable yields. Seeding at 6 and 7 pecks per acre was only slightly inferior. Heavier seeding than usual ordinarily is advisable if seeding is delayed beyond the normal date, as there is less opportunity for the plants to stool.

Certain varieties have been advertised as having the ability to stool more than others and requiring less seed per acre. This claim, in general, is unfounded. Varieties differ in their ability to stool, but all recommended varieties, if seeded at the recommended rate and time and under favorable conditions, will tiller sufficiently to enable the plants to fully occupy the land.

There is no advantage in seeding wheat deeper than necessary to insure sufficient moisture for good germination. In light soils

Figure 18.—Seeding wheat with a disk drill.

the seed may be safely sown deeper than in heavy soils. Covering the seed from 1 to 1½ inches is usually sufficient.

Wheat should be sown early enough to become well established before winter, but not so early that it makes a rank growth or starts to shoot before winter, nor early enough to become infested with hessian fly if this insect is prevalent. Usually this means early enough to permit tillering so that the wheat will cover the ground reasonably well. Unless wheat is grown for pasture, there is seldom any advantage from very early seeding and there is considerable danger from lodging, winterkilling, and the hessian fly.

To avoid fall infestation of wheat by the hessian fly it is advisable to delay fall seeding until the safe date, which is the earliest date in the fall at which wheat can be seeded and still, with average conditions, escape damage from this insect. These dates have been established experimentally and, of course, vary for different parts of the country. Safe average dates for seeding are indicated in Farmers' Bulletin 1627, The Hessian Fly, but as the actual dates may vary from year to year, wheat growers are advised to consult their State agricultural experiment stations or county agents regarding the best seeding date for specific counties or areas for any given year.

PASTURING

Wheat is a highly nutritive pasture crop, because the young plants contain nearly as much protein as does alfalfa hay. Little or no injury to the grain crop results when pasturing is done judiciously. The plants should be well established before pas-

turing begins; otherwise, they may be uprooted by grazing animals. The date for turning in livestock depends upon the growing season. Livestock should be kept off when the ground is wet and soft. If grass or clover has been sown with the wheat, injury is likely to be especially severe if it is pastured when the land is muddy. Spring pasturing may be practiced under favorable conditions, but a loss in grain yield should be expected. The loss is likely to be especially heavy if pasturing is permitted after the plants begin to shoot, which usually takes place a few weeks after spring growth starts. Excessive pasturing at any time of the year is likely to reduce yields.

In the South, wheat, rye, or winter oats provide pasture during the winter months, December to February, when most other pasture crops are dormant. They are profitable crops when sown primarily for pasture during this period.

MULCHING AND CULTIVATING

An application of straw, not exceeding 2 tons per acre, applied as a top dressing in the late fall or early winter, is sometimes recommended as a means of decreasing winter injury. Without doubt, the straw is beneficial in this respect, but in nearly all cases where it has been tried it reduces the yields in seasons when no winter injury occurs. Also a mulch of wheat straw from the preceding crop may be an important source of insect pests such as the hessian fly, strawworm, and jointworm. Mulched wheat often is yellow in the spring, indicating that the straw reduces the supply of available nitrates in the soil. The Ohio Agricultural Experiment Station recommends 1 to 2 tons of straw per acre on unmanured light-colored soils low in productivity where winterkilling is likely to occur. It should be spread uniformly in late November or December. A top dressing of about 15 to 20 pounds of chemical nitrogen per acre applied on mulched land should be profitable.

Rolling wheat in the spring with a corrugated roller is sometimes beneficial, as, for example, when the soil is badly cracked or the wheat plants have been heaved by alternate freezing and thawing. Except in such cases neither rolling nor harrowing is likely to pay. To be beneficial, rolling must be done as soon as growth starts in the spring but not while the topsoil is wet.

HARVESTING

Most wheat in the eastern United States is now harvested with the combine (fig. 19). The binder (fig. 20) is still common in some localities and the cradle is occasionally used in harvesting small fields in the Southeast. The principal advantages of the combine are that the crop can be harvested and threshed more rapidly while the weather is favorable and with a saving in labor. An objection is that the grain cannot be harvested until it is fully ripe and the moisture down to 14 percent or less, thus increasing the risk from storm damage and the danger of spoilage in the bin, which almost inevitably results when damp or slightly immature grain is put into a tight bin in large quantities. In sections of the South where the Angoumois grain moth is present, delayed harvesting also

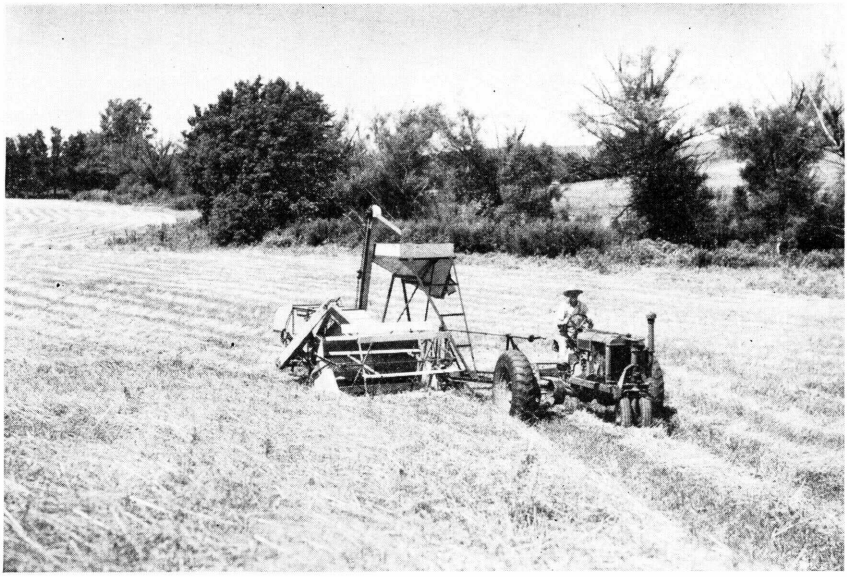

Figure 19.—Harvesting wheat with a 1-man combine.

permits an increase in infestation of the grain by this insect, both in the field and in the bin. The acreage of wheat on individual farms in the eastern United States usually is too small to warrant so heavy an investment in harvesting machinery unless the combine is to be used for custom threshing or for harvesting other crops such as soybeans, cowpeas, or clover. Another objection on many farms is that, with the combine, the straw is scattered over the land instead of being preserved in a stack or the mow for feed and bedding. In some areas the straw is a valuable part of the crop.

Immediately after being cut with a binder, wheat should be shocked. A well-built shock saves considerable grain loss in wet weather. The shock should be large enough to avoid being blown over by winds but not large enough to cause molding of the heads. Usually 12 or more bundles form a shock. The first two bundles should be set upright firmly on the ground with the heads well together. The remaining bundles are set firmly in the stubble around these two. The shock is completed by capping it with two bundles, the stalks of which have been bent down at the band (see cover illustration).

Storing wheat in the barn or stacking it in the barnyard to await threshing is occasionally practiced. The advantages in either case are that the grain and straw are protected from the weather and that threshing may be done at a more convenient time. The principal disadvantage is the additional labor for the extra handling.

In the eastern United States many of the farmers who still use the binder for cutting wheat depend on custom threshing. This means that the interval between cutting and threshing may be several weeks. Well-shocked wheat will, however, be injured little

by ordinary weather, and the more common practice is to thresh direct from the shock rather than to stack the grain or store it in barns.

Where the wheat is to be harvested with the binder, the crop is ready when the straw is well-colored, either purple or yellow, and the grain is in what is known as the hard-dough stage. Where the Angoumois grain moth is prevalent, it is especially desirable to thresh as soon as the grain is dry enough to store, or severe losses may result. The use of storage bins, thorough cleaning of these bins before storage of the new crop, and fumigation of the grain immediately after storage are advisable (see Farmers' Bulletin 2009, Storage of Small Grains and Shelled Corn on the Farm).

Wheat should not be threshed when the straw is tough or the grain damp. It is much easier to dry the grain before threshing than after. The straw is commonly stacked in the open and used for roughage and bedding for stock during the winter. Ultimately it should find its way back to the soil. Close to cities or poultry sections, wheat straw can often be baled and sold at a profit.

GROWING SPRING WHEAT

As indicated on page 22, a small acreage of spring wheat is grown in Wisconsin, northern Iowa, Illinois, and New York. Spring wheat is grown in these areas only when winter wheat cannot be seeded or is killed during the winter. Also, under reasonably favorable conditions, spring wheat may prove more profitable than oats and is considered a satisfactory companion crop for grass and small legume seedings.

Usually spring wheat occupies the same place in the rotation as oats—that is, after corn. Both corn and wheat harbor the fungus (*Gibberella saubinettii* (Mont.) Sacc.) that causes scab. As the

Figure 20.—Harvesting wheat with a binder.

fungus spores live through the winter on old cornstalks and are disseminated by the wind in the spring, there is serious danger of scab infection in spring wheat if the cornstalks are not removed or plowed under. As early seeding is desirable, it is a good plan to plow in the fall if the land is not subject to washing. However, a thorough disking and harrowing in the spring will prove reasonably satisfactory if fall plowing is not done. It is especially important that spring wheat be seeded as early as the ground can be prepared. In a 5-year test at the Illinois Agricultural Experiment Station, in which spring wheat was sown at 10-day intervals beginning as early in the spring as possible, there was a progressive decrease in yield in the later seedings. For the earliest seedings, the average date of which was March 6, the average yield was 25.7 bushels, as compared with only 16.2 bushels for seeding at what is considered the normal date (April 5) for seeding spring small grains.

Spring wheat may be seeded with a drill or sown broadcast, as with an endgate seeder. The former method produces larger yields and is to be preferred. Sometimes, however, seeding can be done earlier if the broadcast method is used, and frequently the gain from the early seeding will more than offset the loss as compared with drilling. The broadcast method also is more rapid and less expensive, except that more seed may be required.

The rate of seeding is usually higher for spring than for winter wheat. The Illinois station recommends approximately 2 bushels per acre.

DISEASES OF WHEAT

Rusts, smuts, scab, powdery mildew, mosaic, septoria leaf blotch, and septoria glume blotch are the most common and most destructive diseases of wheat in the eastern United States. Others, such as take-all, helminthosporium leaf spot, and the nematode disease, may cause important local losses in some years.

Several other diseases such as foot rot, anthracnose, ergot, black chaff, and basal glume rot are of lesser importance.

RUSTS

Two important diseases of wheat in the eastern United States are stem rust and leaf rust; the first is so-called because it attacks the stems of the plants principally, and the second because it attacks the leaves. Both are caused by small parasitic fungi, the spores of which are carried by the wind to the wheat plants, where they develop at the expense of the wheat.

It was not until about 200 years ago that anything of importance was known regarding the nature or cause of rust. The Romans attributed the periodic ravages to a special rust god, Robigus, who resorted to this means of wreaking his vengeance on a wicked people. According to another belief, the rust was due solely to the weather. It is now known that spores must be present and also that weather must be favorable for the development of the fungus.

Of the two kinds of rust, the effects of stem rust are more conspicuous and destructive, as this disease causes badly shriveled

kernels and within a very few days may reduce the yield to a fraction of what would otherwise be obtained. Fortunately, it does not often occur in damaging amounts in the eastern United States, although it may cause severe losses in some years or localities.

Leaf rust is present nearly every year over most of the soft wheat region. It reduces the number and size of kernels and the yield and protein content of the grain. The effect is not conspicuous, however, and losses from it are often underestimated. In the aggregate the losses are heavy in the Eastern States.

Neither leaf rust nor stem rust can be prevented by seed treatment, nor indeed by any kind of treatment that is practicable after the plants once become infected. Destruction of certain kinds of barberry plants on which the stem rust fungus passes one phase of its life cycle reduces losses in the vicinity of the bushes, but widespread epidemics of stem rust usually result from spores carried by the winds from southern Texas or northern Mexico where the disease overwinters on wheat.

Losses from either leaf or stem rust can be reduced by growing resistant varieties or those that are able to escape damage because of their early maturity.

There are varieties of wheat well adapted to some sections of the eastern and southern United States that are highly resistant to leaf rust and some that are resistant to both leaf and stem rust.

SMUTS

There are three kinds of smut of wheat in the eastern United States: Stinking smut, loose smut, and flag smut. Flag smut is practically unknown in the region. It attacks the leaves as well as culms and can be distinguished from the other smuts by that fact. Loose smut is the most important in the eastern United States and can be distinguished by the fact that black spores replace both the grain and the chaff and are blown away by the wind before harvest, leaving the bare central stem (rachis) of the head. Stinking smut, or bunt, on the other hand, replaces only the grain with balls of spores, leaving the outer coat of the kernel and also the chaff intact. As its name implies, it can be distinguished also by its characteristic fetid odor.

BUNT, OR STINKING SMUT

Bunt, or stinking smut, is carried over from one crop to the next as black spores on the seed or as smut balls mixed with the seed. When bunt-infested seed is sown under favorable conditions, such as in moist, cool soil, the smut spores germinate and the fungi penetrate into and infect the young seedlings. As the infected plants grow, the parasitic smut organisms grow within them and produce what are commonly called smut balls instead of kernels in the heads. When the wheat is ripe, the presence of these smut balls is made evident by the odor and the appearance of the smutted heads (fig. 21, *B*). The smut balls are grayish brown or almost black and are about the size and shape of the wheat kernels. When crushed in the fingers, the smut balls are found to be filled with foul-smelling smut dust—the spores of the causal fungus. Most wheat growers are familiar with smut balls as they are threshed with wheat and with the foul-smelling odor as it comes

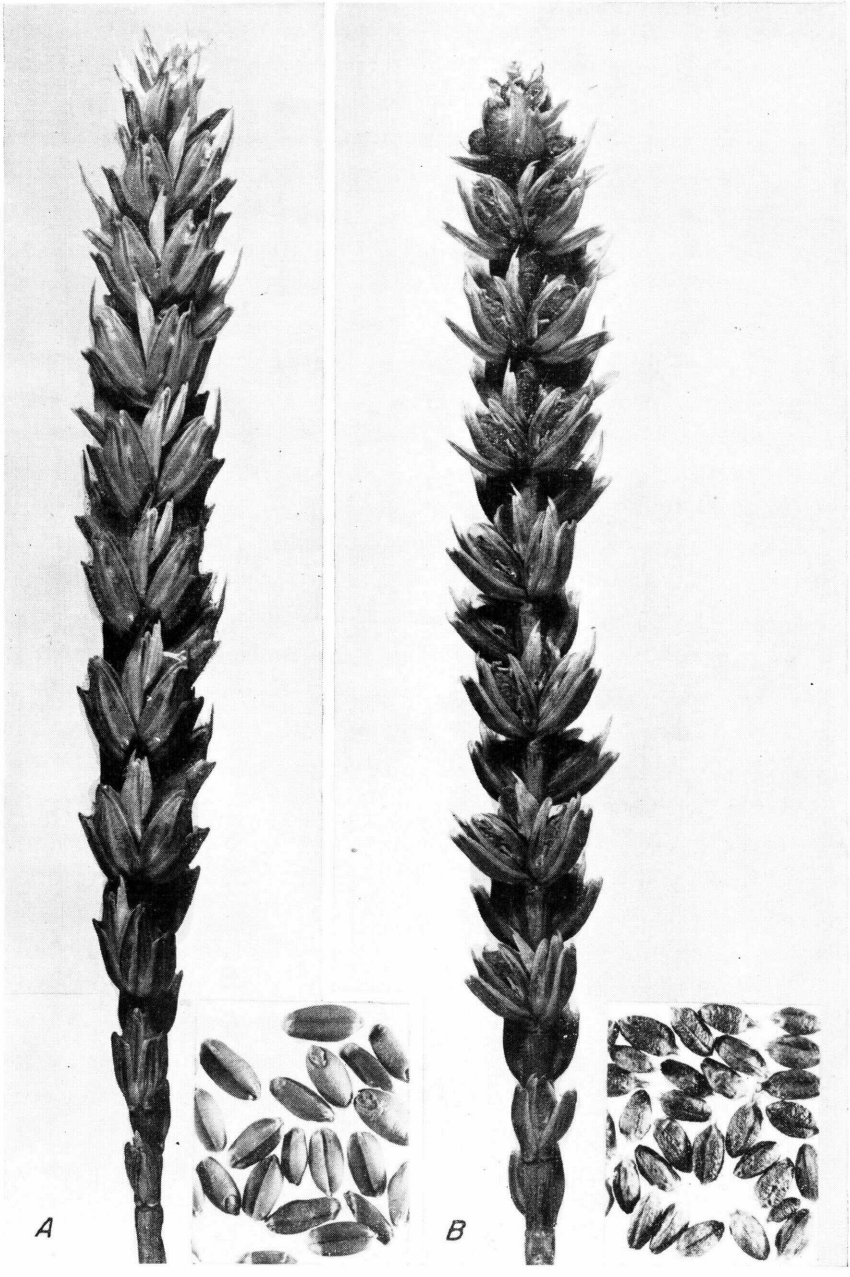

Figure 21.—*A*, Healthy wheat head and wheat kernels; *B*, bunted wheat head and stinking smut balls.

from the machine. Badly smutted wheat must be washed or "scoured" before milling to remove both the smut spores and the odor. Because of this, smutty wheat is discounted on the market.

No varieties of wheat commonly grown in the eastern United States are resistant to all strains of bunt, although some varieties are more resistant than others. Therefore, seed treatment, for the present, must be relied upon for control.

Very badly smutted wheat should not be used for seed. Moderately smutted seed can be used safely if thoroughly cleaned in a good fanning mill and then well treated with suitable seed disinfectants.

Seed Treatment for Bunt

The most widely used seed treatments for stinking smut, or bunt, in winter wheat are the New Improved Ceresan (5 percent ethyl mercury phosphate) dust treatment, the Ceresan M (7.7 percent ethyl mercury p-toluene sulfonanilide) dust or slurry treatment, the copper carbonate dust treatment, and the basic copper sulfate treatment. Any of these is satisfactory in the eastern United States where soil infestation does not occur, provided the seed wheat has been thoroughly cleaned before treatment to remove all smut balls. Wheat that is black with smut spores is unsuitable for seed even when treated.

Seed-treatment compounds may be purchased at drug stores, seed houses, or other places where seed and similar products are for sale. Information about seed-grain treaters and instructions for treating with each of the compounds are given in United States Department of Agriculture Miscellaneous Publication 219, Treat Seed Grain.

LOOSE SMUT

Loose smut is common in the wheatfields of the eastern United States and causes an average loss in yield of about 1.5 percent. Losses from this disease in individual fields may amount to 30 percent or more.

Loose smut is very noticeable as soon as the wheat heads appear (fig. 22). The glumes and other floral parts of the newly emerged heads are almost completely replaced by black masses of smut. For this reason loose smut is frequently called blackhead. The spores are held loosely in the smutted heads and are carried away at the time the healthy wheat heads are in flower by winds, rain, insects, or other agencies. After the smut is gone only the inconspicuous central stalk (rachis) of the head remains. Some of the spores, in the course of their dissemination, are carried to the flowers within the glumes, or chaff, of the sound wheat heads. Here the spores germinate and produce an internal infection of the developing kernels. When mature, the infected kernels cannot be distinguished from noninfected kernels. However, if the infected kernels are used for seed without being treated, the internally borne fungus starts growing as the kernel germinates and spreads upward into the plant as it develops. Finally, when the heads appear, they are composed of the smut masses described above.

Because the loose smut organism invades the internal parts of the kernel, the disease cannot be controlled by treating the seed with the easily applied surface disinfectants, as described for

Figure 22.—Loose smut in wheat: The infected plants are shorter than the noninfected plants, and the glumes (chaff) and grain have been replaced by the black spores of the smut fungus.

bunt. It may, however, be effectively controlled by a modified hot-water treatment. This treatment is recommended only for a sufficient quantity of seed to sow a plot some distance from the main crop that will serve as a source of clean seed for the following year. It is difficult to apply, however, even to small lots of seed and has not proved popular with growers. In general, therefore, when loose smut becomes prevalent, the best method of combating it is to obtain seed from a smut-free field. If it seems desirable to apply the hot-water treatment, directions may be obtained from the State agricultural experiment station or from the United States Department of Agriculture. Varieties adapted to several Eastern States are resistant to loose smut.

FLAG SMUT

Flag smut formerly occurred in limited areas in Illinois, Missouri, and Kansas. On susceptible varieties it may cause losses of more than 30 percent, but the resistant varieties now being grown in the areas formerly infested have practically eliminated the disease.

Flag smut produces dark stripes in the leaves, sheaths, and stems. It stunts the plants and usually prevents the formation of normal heads (fig. 23). It is carried over from one crop to the next, both with the seed and in the soil of infested fields. It may be controlled most advantageously by the use of adapted, highly resistant or immune varieties of soft red winter wheat, such as Fulhio, Thorne, Vigo, Newcaster, and Fulcaster, or hard red winter wheat, such as Pawnee.

If susceptible varieties are grown on infested land, the seed should be very thoroughly cleaned and carefully treated with New Improved Ceresan, as described for stinking smut.

SCAB

Scab occurs most commonly when wheat follows corn in the rotation and occasionally it takes a very heavy toll. Some years it is severe in the Corn Belt and in the East Central States.

The scab fungus attacks the seedlings and also the heads of the plants. The attacked seedlings are killed or greatly weakened, and the attacked parts of heads are killed. Individual spikelets or various parts of heads may be killed (fig. 24). Usually pink or salmon-colored masses of spores of the scab fungus are evident at the edges or bases of the affected glumes. The kernels in killed portions of the head become much shrunken, almost white, and scabby in appearance; hence, the name "scab."

The scab fungus is carried over from one crop to the next, both in the seed and on crop refuse, such as cornstalks in the fields. The fungus carried with the seed infects the wheat seedlings more or less severely, depending on conditions at seeding time, and causes seedling blight. The fungus from cornstalks allowed to remain over winter on the surface of the soil may infect the heads and cause head blight. For this reason the disease is most severe where wheat follows corn.

Scab is difficult to control. In areas where it is frequently severe, the most effective control is obtained by not sowing wheat after corn. Where it is necessary to do so, the cornstalks either

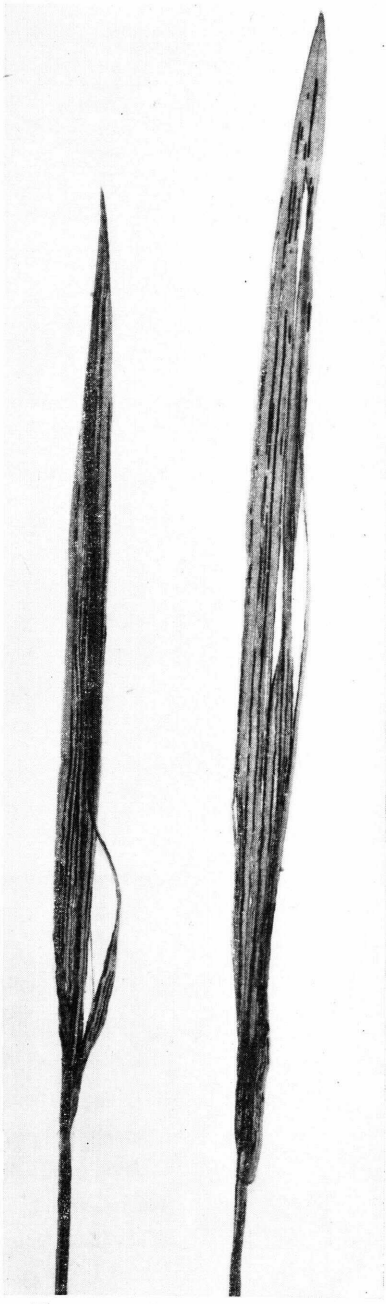

Figure 23.—Flag smut in leaves and stalks of wheat.

should be plowed under very thoroughly or cut as low as possible and removed from the field before the land is disked. In any case, the seed should be cleaned thoroughly and treated with New Improved Ceresan before sowing.

Figure 24.—Scab on wheat heads: Healthy head (left); partly killed head (center); head entirely killed (right).

Some wheat varieties are less susceptible to scab than others, but none is even moderately resistant.

TAKE-ALL

Take-all has been reported from the following States in the eastern United States: Kansas, Arkansas, Illinois, Indiana, Ohio, Tennessee, North Carolina, Virginia, Maryland, Michigan, New York, and New Jersey. In Kansas, in some years, it destroyed 10 to 50 percent of the crop in infested fields. Fortunately, in-

fested fields are comparatively few; but, because of possible heavy losses from the disease, it should be carefully watched. It has been of minor importance in recent years.

Take-all may kill the plants in the rosette stage; it may so dwarf them that only a few low culms with small heads are formed, or it may kill plants that have attained about the normal size as the heads are beginning to fill. Such plants turn almost white; therefore, this development of the disease is sometimes called whitehead. Nearly all the plants in certain spots or scattered plants in a field may be killed. Stems of infected plants usually are black to a height of 1 or 2 inches above the soil, and the plants pull easily because of the rotted, infected roots.

The take-all fungus is not carried with the seed but persists in the soil for several years. The only feasible control measure known is to keep wheat, barley, and rye off infested land for about 4 years. In the meantime it is advantageous to plow under a green-manure crop, such as sweetclover. No resistant varieties are known.

POWDERY MILDEW

Powdery mildew has caused considerable damage in some localities, especially in the States along the Atlantic coast from New York to Georgia. When mildew develops in the fall and weather conditions are favorable, it may remain active on wheat throughout the winter and spring, causing almost complete loss in individual fields. Such conditions prevailed on the coastal plain of South Carolina in 1949 when some wheatfields were plowed under before harvest.

The fungus causing mildew grows in the leaves and leaf sheaths and produces gray powdery spores in lesions on the surface. These spores are carried by the wind to other plants, to other fields, and from one locality to another. The infested areas on leaves are killed, and in severe cases the entire leaves may be killed. Wheat severely infected with mildew is very likely to lodge, as the disease weakens the stems.

The development of mildew is favored by rank, succulent growth and by humid, cloudy weather. Excessive use of nitrogen fertilizers may increase losses from mildew.

The growing of resistant varieties is the most successful method of controlling mildew. There are many races of mildew that attack different varieties of wheat. Some wheat varieties, however, are resistant to many of these races. The varietal reaction when known is mentioned under the discussion for each variety.

SEPTORIA LEAF BLOTCH AND SEPTORIA GLUME BLOTCH

Septoria leaf blotch occurs rather widely over the eastern soft winter wheat region and in some localities losses are serious in many years. It appears during the fall, spring, or early summer as light-green to yellow spots between the veins of leaves. The lesions form light-brown irregular blotches that have a speckled appearance as the small, black fruiting bodies appear. Under severe conditions the leaves soon die.

Septoria glume blotch also occurs over the entire eastern soft winter wheat region and may cause shriveling of the kernels. It

occurs most commonly on the glumes of the spike and nodal tissues of the stems. The lesions are somewhat oblong, light to dark brown in color, and the fruiting bodies are less conspicuous because the lesions are darker than in the leaf blotch.

Some varieties are moderately resistant to the septoria diseases. Crop rotation and plowing under volunteer wheat plants in the fall also help to reduce losses in areas where these diseases occur.

MOSAIC

There are several closely related mosaic diseases of winter wheat in the eastern United States. They are caused by viruses. In the most susceptible varieties, losses up to 75 percent or more may occur in heavily infected fields.

The different mosaic diseases affect wheat plants differently, and the same mosaic may affect different varieties somewhat differently. On some susceptible varieties, such as Harvest Queen, mosaic that occurs in the Illinois-Indiana area may cause extreme dwarfing or rosetting as well as leaf mottling. On other susceptible varieties, only the leaf mottling occurs. This mosaic, as well as the one that occurs in the Southeast, is soil-borne. Many adapted varieties are resistant in both areas. The mosaic that occurs farther west in the hard winter wheat belt is not carried over in the soil.

Only resistant varieties should be sown in the soft winter wheat area when the soil is known to be infested with mosaic.

NEMATODE DISEASE

The nematode disease occurs to some extent in Maryland, Virginia, West Virginia, North Carolina, South Carolina, and Georgia. Losses on individual farms may range from very slight to as much as 70 percent. The disease occurs on both wheat and rye and is caused by a species of very small roundworm, called nematode or eelworm, that forms galls instead of kernels in the wheat heads. Healthy kernels of wheat and some nematode galls are shown in figure 25.

The nematode is carried over from one crop to the next in galls with the seed or in infested soil. The disease may be controlled by

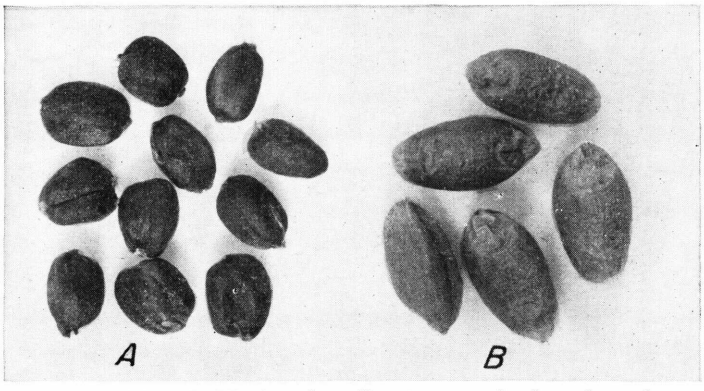

Figure 25.—*A*, Nematode galls; *B*, normal wheat kernels.

sowing noninfested seed on noninfested soil. It is extremely difficult to remove all nematode galls from seed wheat. Therefore it is usually best to obtain seed that is known to be free from them and to sow it on land that has neither grown nematode-infested wheat or rye nor had infested manure or infested crop refuse spread on it for 1 year.

WEEDS IN WHEAT

Weeds are often a serious problem in wheatfields in the eastern United States. The most serious are those, like the European or field bindweed, Canada thistle, and wild onion or wild garlic, that live from year to year by virtue of underground stems or bulbs in which reserve foods are stored to carry the plants through unfavorable periods of the year. Such plants are commonly known as perennials. They are regarded as the most serious because they are the most difficult to eradicate or control. They occur not only in wheat but in other crops as well. Fortunately, with the exception of wild garlic, they are not widespread in the eastern United States. A second important class is the winter annuals, such as chess, or cheat, corncockle, dogfennel, chickweed, and skeletonweed, that start growth in the fall with the wheat and mature the following year. Such weeds are troublesome, but usually they can be controlled or completely eradicated by good farming methods.

The use of chemical sprays on weeds in wheat in the Eastern States is in the experimental stage. Fall spraying with 2,4-D has not been uniformly satisfactory because it often causes malformation of the plants and heads. Preemergence sprays are more promising, but they retard the growth of the wheat plants. Spraying in the spring has caused less noticeable injury to the wheat, but the control of such weeds as fennel, dock, and wild onion has been unsatisfactory. For more complete information on the use of chemical sprays see Farmers' Bulletin 2005, Using 2,4-D Safely.

Wild garlic probably is the most objectionable weed in eastern wheatfields. The plant grows from underground bulbs and also from aerial bulblets that ripen with the wheat. The green bulblets are very difficult to separate from wheat, but they shrink during storage and if thoroughly dry may be removed by means of the fanning mill or other cleaning equipment. If not removed, they form gummy masses on the rolls in flour mills and impart a strong odor of garlic to the flour.

In the official grain standards of the United States, wheat containing two or more garlic bulblets or their equivalent in approximately 2 pounds of wheat is specially designated as "light garlicky" or "garlicky." Such wheat is discounted in price. Wild garlic is a very difficult weed to exterminate, and every effort should be made to keep it off the farm. Those who wish to attempt to eradicate or control it will find further information in United States Department of Agriculture Leaflet 43, Wild Garlic and Its Control.

Cheat, or chess, is one of the most common weeds in wheatfields in the eastern United States. It is a species of bromegrass and

not, as commonly supposed, a degenerate form of wheat. In fields sown to winter wheat, cheat will often survive when much of the wheat is winterkilled, a fact that sometimes causes fields of wheat apparently to change to cheat over winter. The seeds of cheat are difficult to remove from wheat and are often sown with it, thus perpetuating the cheat from year to year. However, it is possible to remove cheat seed from wheat by careful adjustment of the fanning mill. When this is done and a good farming system including rotation of crops is used, there is not likely to be serious trouble from this pest. Fortunately, the seeds of cheat do not live long in the soil.

Corncockle, or purple cockle, often is found in fields of winter wheat in the eastern United States. The rough, dark-colored seeds are difficult to separate from wheat. If present in appreciable quantities, they produce a dark, bad-flavored flour of poor quality. Also the cockle seeds are reputed to be poisonous to poultry. The seeds do not live long in the soil, and the use of clean seed, together with careful cultivation and suitable rotations, will eradicate the pest.

Dogfennel, chickweed, skeletonweed, wintercress, and similar weeds crowd the stand of winter wheat and may reduce the yield seriously if they occur in large numbers. With the exception of chickweed and wintercress, they are likely to be less troublesome in late seedings than in early ones. They also can be controlled by good farming methods.

INSECTS THAT ATTACK WHEAT[1]

HESSIAN FLY

In the principal areas where soft red winter wheat is grown, the hessian fly (*Phytophaga destructor* (Say)) is without doubt its most formidable insect enemy. A portion of a wheat plant infested with hessian fly maggots is shown in figure 26. The most important and practical means of controlling this pest, as indicated on page 29, is to plant winter wheat at a date that will delay the appearance of the young wheat above ground until after the main brood of flies has emerged and died. Sound cultural practices that contribute to the vigor of the growing crop are an important help in combating the hessian fly. Chief among these practices are plowing under the stubble of the preceding wheat crop before the flies emerge from it in the early fall, prompt destruction of volunteer wheat, the sowing of good seed, and the promotion of rapid, vigorous growth by proper fertilization and planting in a well-prepared, firm seedbed. Improved wheat varieties resistant to the hessian fly and variously adapted for growing in certain parts of the Great Plains and California have been released to farmers during the past few years. Other resistant varieties better adapted to wheat-growing conditions of the eastern United States are in the process of being developed, and, although not yet ready to be released, these resistant varieties may prove a great help in combating this pest in the future.

[1] Contributed by the Division of Cereal and Forage Insect Investigations, Bureau of Entomology and Plant Quarantine, U. S. Department of Agriculture.

CHINCH BUG

The chinch bug (*Blissus leucopterus* (Say)) (fig. 27) feeds on and deposits eggs upon the growing wheat plants, but under conditions of vigorous growth and early maturity the bugs usually migrate to corn before the wheat has been seriously injured. In the spring the bugs congregate in the thinner, poorer parts of the fields, and in years of extreme abundance may kill or greatly reduce the growth of the wheat in such areas. A heavy stand of soft red winter wheat is seldom seriously injured by chinch bugs.

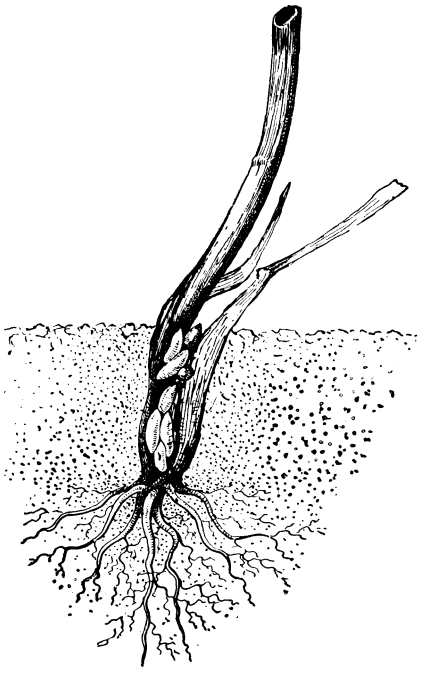

Figure 26.—Hessian fly maggots beneath leaf sheath in the soil. Natural size.

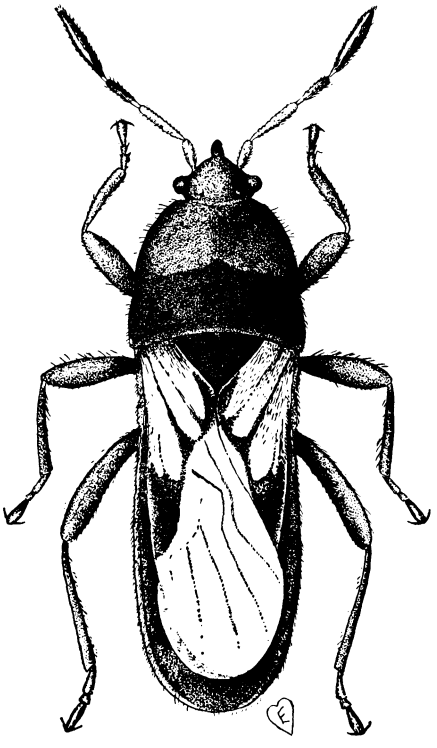

Figure 27.—An adult chinch bug. Enlarged 19 times.

Promoting a heavy, thrifty stand of wheat, preferably intermixed with clover, is a good protective measure. Anything that can be done to produce this condition, such as thorough tillage, ample fertilization, and timely seeding, helps to reduce injury from the bugs.

In years when chinch bugs are abundant, spring wheat grown within the infested areas is almost certain to be seriously damaged. Its younger stage of growth at time of infestation and longer period of succulence thereafter render it most attractive to the bugs.

Burning in the winter of grasses and leaves in which the chinch bug hibernates is not generally a practical or effective method of control. However, burning may be of value within limited areas

where large numbers of the bugs have congregated in the grasses, if done before the first flight of the bugs in spring.

Farmers' Bulletin 1780, How to Fight the Chinch Bug, contains further information regarding the chinch bug.

WHEAT JOINTWORM

The wheat jointworm (*Harmolita tritici* (Fitch)) is one of the most consistently injurious insect enemies of soft wheat in the East Central and Atlantic States. Heavy outbreaks of this pest occurred in 1949 over most of Indiana, Illinois, and Kentucky.

The way the wheat jointworm attacks the plant is illustrated in figure 28. Its work usually remains undetected, and losses caused by it are often attributed to unfavorable weather or cul-

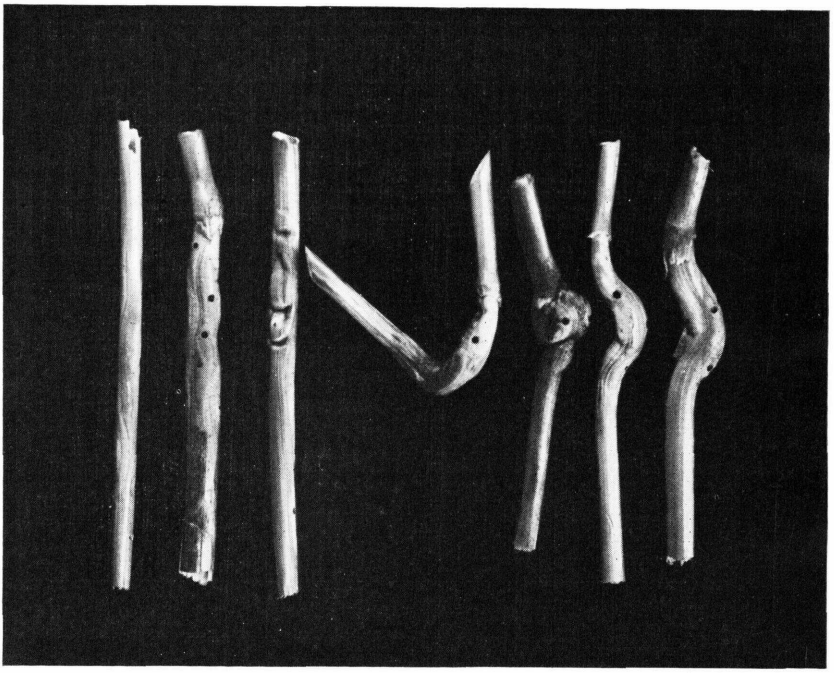

Figure 28.—Work of wheat jointworm larvae. Natural size.

tural conditions. It robs the heads of nourishment by causing hard knots or galls in the stems. Where very abundant, it may cause lodging of the ripening grain and thus call attention to its presence.

The jointworm may be controlled by cutting the wheat as high as practicable and plowing under the stubble immediately after harvest in order to bury it so that the adults cannot emerge. This procedure is not generally practicable where grass, clover, or other legume is seeded with the wheat, except in cases of extremely heavy infestation.

Farmers' Bulletin 1006, The Wheat Jointworm and Its Control, contains additional information on this insect.

SAWFLIES

The black grain stem sawfly (*Cephus tabidus* (F.)) and the European wheat stem sawfly (*C. pygmaeus* (L.)) occur in the North Atlantic States. The first species has now spread through eastern Ohio, Virginia, and some northern counties in North Carolina. During the period 1934-37 it caused much damage to wheat in western Pennsylvania and eastern Ohio. The European wheat stem sawfly is now found not only in New York State, where it first became established, but in Pennsylvania, New Jersey, Delaware, and Maryland, where it is largely replacing the other species. Except for a few localized attacks in southern New Jersey, neither species has caused much damage in recent years.

Where the sawflies have become abundant, serious losses are likely as a result of the breaking-over of straw, shattering of grain, and difficulty of harvesting.

The sawfly larva is a yellowish-white worm with a brown head. It develops from an egg laid by a small wasplike insect inside the wheat stem about the time of heading. The worm feeds inside the stem and gradually works its way downward until by harvesttime it has become full-grown and about three-eighths of an inch long. It then cuts a ring almost through the stem wall close to the ground, leaving just enough outside fiber intact to hold the stem erect until it can securely plug the end of the stub, in which it forms a resting cell. As the stem dries and becomes brittle, the weight of the head, together with wind or rain, causes the stem to break off close to the ground where the worm has cut around it. The larva remains in the stub until the following spring, when it changes to the adult, wasp stage and emerges to lay eggs in the currently maturing crop.

Cultural practices and fertilizers that encourage a strong, heavy stand help materially in reducing losses due to sawflies and are recommended throughout the infested areas.

To avoid much loss from falling straw in heavily infested areas, the wheat should be cut as early as possible. The crop thus can be harvested before much lodging caused by sawfly injury occurs. Obviously, the combine harvester, which operates successfully only in mature, dry grain, is not suitable for use in heavily infested fields. However, the fallen straw can be harvested after the regular harvest with a pick-up attachment supplied for most combines by the manufacturers. This procedure considerably increases the cost of operation.

When raking becomes necessary, it is good practice to rake early in the morning while the wheat is still damp, in order to reduce shattering.

ARMYWORM

In years favorable to its development, the armyworm (*Cirphis unipuncta* (Haw.)) (fig. 29) sometimes inflicts serious and widespread damage on the winter wheat crop. This is most likely to occur in the southern halves of the East Central and Middle Atlantic States and to follow a mild, open winter that has emerged

into a cold, wet spring. The armyworm is often effectively suppressed by its numerous natural enemies, but such a sequence of favorable weather conditions may permit it to escape them and do great injury to the growing wheat. In its early stages, the armyworm usually works concealed among the lower leaves of the grain, and frequently its presence remains undetected until it is almost full-grown and is doing great damage to the heads of the grain. Its early detection is necessary to prevent serious loss.

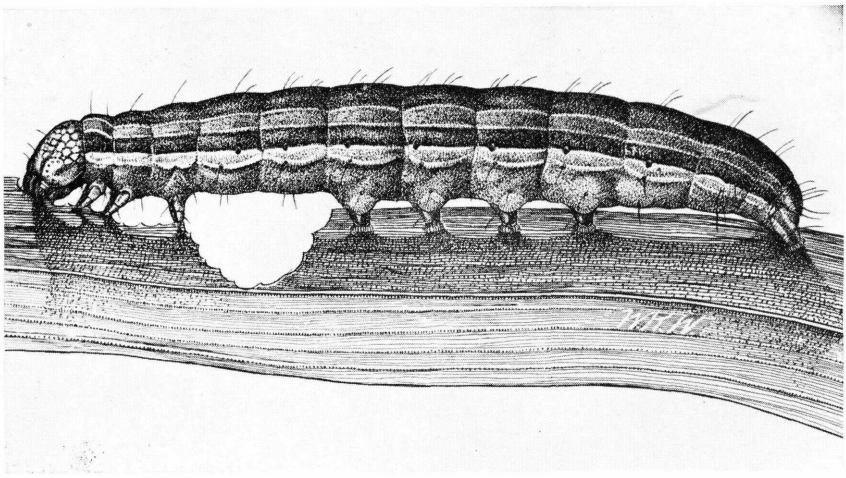

Figure 29.—An armyworm larva. Enlarged about 4 times.

The prompt distribution of a poison bait is an effective method of destroying the armyworm. The formula for such a bait is as follows: Wheat bran, 50 pounds; paris green or white arsenic, 2 pounds; water, 6 gallons. Mix the bran and poison together while dry; then add the water and stir well until thoroughly mixed. Broadcast the bait thinly, not in lumps, over the infested field late in the afternoon.

Several of the new insecticides will kill armyworms, especially if applied when the larvae are young. Excellent control has been obtained with a toxaphene spray applied by aircraft at the rate of 1½ to 2 pounds of toxaphene in 2 gallons of spray per acre. For the 1½-pound dosage mix 1 quart of 60-percent or 1½ quarts of 45-percent toxaphene emulsifiable concentrate thoroughly with water to make 2 gallons. A spray containing 1½ pounds of DDT in 5 gallons of water per acre has also given satisfactory control when applied by aircraft or with ground equipment. Dusts containing 20 percent of toxaphene or 10 percent of DDT, applied at the rate of 20 pounds per acre, have also provided good control of the armyworm.

CAUTION: Paris green, white arsenic, toxaphene, and DDT are poisons. Handle them with care, in accordance with directions

given on the containers, and keep them out of reach of children and livestock. Do not feed straw or hay from crops that have been treated with either toxaphene or DDT to dairy animals or to meat animals being finished for slaughter.

The measures that aid in the control of this insect are described in Farmers' Bulletin 1850, The Armyworm and Its Control.

OTHER INSECT PESTS OF WHEAT

Other insects that sometimes seriously injure winter wheat are greenbugs, sod webworms, and wireworms. For further information regarding insect pests of wheat, apply to the Bureau of Entomology and Plant Quarantine, United States Department of Agriculture, Washington 25, D. C.

INDEX OF WHEAT VARIETIES GROWN IN THE EASTERN UNITED STATES

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